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Proposed Re-evaluation Decision

PRVD2016-20

# Imidacloprid

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## Executive Summary

### Health Canada's Pest Management Regulatory Agency (PMRA)

Health Canada's primary objective in regulating pesticides is to protect Canadians' health and their environment. Pesticides must be registered by Health Canada's Pest Management Regulatory Agency (PMRA) before they can be imported, sold, or used in Canada. Pesticides must go through rigorous science-based assessments before being approved for sale in Canada.

All registered pesticides must be re-evaluated by the PMRA on a cyclical basis to make sure they continue to meet modern health and environment safety standards and continue to have value. This may happen even sooner if new information becomes available. Re-evaluations may result in:

- changes to how products are used;
- changes to product labels to meet current health and environmental standards; or,
- removing products from the market to prevent future harm to health or the environment.

### Re-evaluation of Imidacloprid

Imidacloprid is a neonicotinoid insecticide used by commercial applicators and growers to manage insects on a large number of agricultural crops, trees and turf. It can also be used at home to manage insects on lawns, as well as fleas or ticks on cats and dogs.

When conducting the re-evaluation of imidacloprid, the PMRA reviewed scientific information provided by pesticide manufacturers, provinces and Environment and Climate Change Canada, as well as published scientific information. For the environmental assessment, potential risks to organisms on land and in water were examined. Risks to bees and other pollinators were not a part of this re-evaluation, as they are part of an ongoing pollinator risk assessment (see Re-evaluation Note [REV2016-05, \*Re-evaluation of Imidacloprid – Preliminary Pollinator Assessment\*](#) for more details). For the human health assessment, the following routes of exposure were examined: food, drinking water, exposure when applying the pesticide, and coming into contact with the pesticide after it has been applied.

### Key Findings

The environmental assessment showed that, in aquatic environments in Canada, imidacloprid is being measured at levels that are harmful to aquatic insects. These insects are an important part of the ecosystem, including as a food source for fish, birds and other animals. Based on currently available information, the continued high volume use of imidacloprid in agricultural areas is not sustainable.

The environmental assessment also found that there is a potential risk to birds and small mammals from feeding on seeds that are treated with imidacloprid, however, it is expected that good agricultural practices and equipment could reduce this type of exposure.

The health assessment did not identify human health concerns from any exposure route when used according to current label standards.

### **Next Steps**

For the protection of the environment, PMRA is proposing to phase-out all the agricultural and a majority of other outdoor uses of imidacloprid over three to five years. PMRA will consider alternate risk management proposals, provided that they can achieve acceptable levels in the environment in the same timeframe.

The proposed re-evaluation decision is now open for public consultation for 90 days from the date of this publication. PMRA is inviting the public to submit comments on the proposed re-evaluation decision for imidacloprid including proposals that may refine the risk assessment and risk management. Once PMRA considers the comments and any information that are received during the public consultation period, it will publish a final decision.



## Overview

### What Is the Proposed Re-evaluation Decision for Imidacloprid?

The evaluation determined that under current conditions of use, the environmental risks for most products containing imidacloprid do not meet current safety standards. Therefore, the PMRA is proposing to cancel the following uses:

Products used by commercial applicators and growers for:

- trees (except when applied as a tree trunk injection)
- greenhouse uses
- outdoor agricultural uses (including ornamentals)
- commercial seed treatment uses
- turf (such as lawns, golf courses, and sod farms)

Products used at home for:

- lawns

An evaluation of the scientific information has determined that certain uses of imidacloprid products have value and do not pose risks to human health or the environment. These uses include:

Products used by commercial applicators for:

- use in and around structures (such as homes and buildings)
- trees when applied as a tree trunk injection

Products used at home for:

- flea, tick and lice treatment on cats and dogs

Before making a final re-evaluation decision on imidacloprid, the PMRA will accept and consider written comments on this proposal received up to 90 days from the date of this publication. Please forward all comments to Publications (see contact information on the cover page of this document). The PMRA will consider any additional data/information submitted during the consultation period in the final decision.

After the final re-evaluation decision is made, any required changes to the use-pattern will be implemented within three years. For any uses requiring phase out where there are no suitable alternative products, a phase-out period of up to five years, from the date of the final decision, may be considered to allow time for the development of alternative products. PMRA will be consulting agricultural producers and other stakeholders to consider the availability of suitable alternatives.

## **What Does Health Canada Consider When Making a Re-evaluation Decision?**

Under the *Pest Control Products Act* (PCPA), all registered pesticides must be re-evaluated by the PMRA on a cyclical basis to make sure they continue to meet modern health and environmental safety standards and continue to have value. The re-evaluation considers data from pesticide manufacturers, published scientific reports, information from other regulatory agencies and other available, relevant information. To reach its decisions, the PMRA applies internationally accepted hazard and risk assessment methods and modern risk management approaches and policies.

For more information on how the PMRA regulates pesticides, as well as the assessment process, please visit the Pesticides and Pest Management portion of Health Canada's website at [healthcanada.gc.ca/pmra](http://healthcanada.gc.ca/pmra).

## **What is Imidacloprid?**

Imidacloprid is a neonicotinoid insecticide registered to manage insects on a large number of agricultural crops including cereals and grains, legumes, pulses (beans, chickpeas, lentils and peas), oilseeds and horticultural crops, specialty crops and on Christmas trees, ornamentals, turf, forestry/woodlots, indoor and outdoor structural sites, and pets. It is applied using ground, aerial and seed treatment equipment, tree injection applicators, bait stations and spot-on applicators to cats and dogs.

## **Environmental Considerations**

### **Can Approved Uses of Imidacloprid Affect the Environment?**

**Imidacloprid breaks down slowly in soil and tends to move into water, where it poses risks of concern to aquatic insects. Risks of concern have also been identified for soil dwelling organisms, beneficial arthropods, birds, and small, wild mammals.**

Based on its chemical properties, when it is released into the environment, imidacloprid is expected to break down slowly in soil and move into surface water and groundwater. This has been confirmed by available monitoring data which shows that imidacloprid is being detected frequently in Canadian surface and groundwater.

Imidacloprid is not likely to accumulate in the tissues of organisms such as fish. As imidacloprid eventually breaks down further in the environment, the resulting break-down products are not expected to be a concern to terrestrial and aquatic life.

### **Risks of concern were identified for aquatic insects.**

In aquatic environments, exposure to imidacloprid from spray drift and from runoff may result in toxic effects to aquatic insects. Imidacloprid is not expected to pose a direct risk to fish, amphibians, algae or aquatic plants.

The aquatic risk assessment relied on the results of environmental modelling in conjunction with Canadian water monitoring information. Environmental modelling predicted levels of imidacloprid in aquatic environments that would be expected to pose risks to aquatic invertebrates, including aquatic insects. Robust environmental monitoring from several areas of intense agricultural activity in Ontario and Quebec further support these findings as imidacloprid is detected frequently in surface water at levels well above concentrations that may result in toxic effects to insects. These regions include both outdoor mixed agricultural uses (for example, potatoes and vegetables) as well as greenhouse uses, where imidacloprid can be applied to seeds, plants or soil (in other words, as a seed treatment, spray application, or soil application). The risks to freshwater insects cannot be attributed to a specific crop or application method. Although robust monitoring data are not available for all regions in Canada, given the chemical properties of imidacloprid, it is anticipated that elevated levels may be found in many agricultural areas where there is a high volume of use. For these reasons, the PMRA cannot exclude any particular crop from risk management based on the available information. Monitoring data likely provide an underestimate of actual exposure, as sampling typically does not capture peak concentrations.

**In terrestrial environments, imidacloprid poses a potential risk to soil dwelling organisms, beneficial arthropods, birds and small, wild mammals.**

In terrestrial environments, imidacloprid poses a potential risk to soil dwelling organisms and beneficial arthropods. This risk triggers a requirement for precautionary label statements.

The ingestion of seed treated with imidacloprid may pose a risk to birds and small mammals. For some types of seeds, ingestion of a small number of seeds could result in toxic effects in birds and mammals. However, there is uncertainty whether or not certain treated seeds would be an attractive food source for birds and mammals. Risk mitigation measures include requirements to incorporate or remove any spilled or exposed treated seed from the soil surface to help reduce exposure.

**The environmental assessment indicates that the continued use of imidacloprid in agricultural areas is not sustainable.**

Precautionary label statements are currently on all product labels to reduce the potential for runoff to adjacent aquatic habitats. In addition, there are label restrictions prohibiting release of imidacloprid from greenhouses into surface waters. Despite these current label statements, levels of imidacloprid posing a risk to aquatic insects have been found in Canadian surface waters where imidacloprid is used for pest management in agriculture (including greenhouses).

Given the risks that have been identified and considering the available information, effective risk mitigation through a use-reduction strategy would be difficult to achieve for several reasons. It would be difficult to identify the specific uses that are causing the elevated levels in water given that much of the water monitoring data were from mixed-use areas of agriculture. In addition, it is not possible to accurately predict how much use reduction would be necessary to achieve acceptable levels of imidacloprid in the environment and, therefore, any use-reduction strategy would require extensive and comprehensive water monitoring information to confirm that risk reduction targets are being achieved. It is also not possible to estimate how long a reduction in

environmental levels would take. In addition, in sectors where imidacloprid is approved for use but not currently used extensively, intensification of use in the future may lead to additional risks of concern. Given the above, phase-out of all outdoor agricultural, ornamental, turf, and tree uses (except tree injection uses) and greenhouse uses of imidacloprid is being proposed.

## **Health Considerations**

### **Can Approved Uses of Imidacloprid Affect Human Health?**

**It is unlikely that use of imidacloprid will affect your health when used according to the label directions.**

Potential exposure to imidacloprid may occur through diet (food and water), when handling and applying products containing imidacloprid or by entering areas that have been treated. When assessing health risks, two key factors are considered: the levels at which no health effects occur in animal testing and the levels to which people may be exposed. For pesticide regulation, the acceptable level of exposure to humans is set to at least one hundred times lower than the level at which no effects in animal testing were observed. The risk assessment also takes into consideration the exposure of vulnerable populations such as children and nursing mothers.

For the re-evaluation, acute, short, and long term (lifetime) animal toxicity tests from pesticide manufacturers, as well as information from published scientific literature were assessed for the potential of imidacloprid to cause health effects (including effects on the brain, immune system, reproduction system, and human development, and the potential to cause cancer). There was no indication that young animals were more sensitive to health effects than adult animals. The risk assessment protects against the effects observed in animal studies by ensuring that the level of human exposure is well below the lowest level at which these occurred.

### **Dietary risks from food and water are not of concern.**

The dietary assessment took into consideration the potential for exposure to imidacloprid residues<sup>1</sup> in food and drinking water for the general population and different subpopulations, including children and women of reproductive age. No risks of concern were identified.

### **Risks from use at home or to bystanders are not of concern when used according to label directions.**

People may potentially be exposed when applying imidacloprid to pets for flea and tick treatments (or handling a pet afterwards) or to lawns and turf. Visiting residential or recreational areas treated with imidacloprid (includes parks, indoor environments, and golf courses) can also result in potential exposure. Incidental oral exposure may also occur for children playing in treated areas. No risks of concern were identified for these exposure routes.

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<sup>1</sup> A complete list of MRLs specified in Canada can be found in PMRA's MRL Database, an online query application that allows users to search for specified MRLs, regulated under the *Pest Control Products Act*, for both pesticides and food commodities (<http://pr-rp.hc-sc.gc.ca/mrl-lrm/index-eng.php>).



When potential exposure in and around homes was combined with potential dietary exposure (food and drinking water), this did not result in risks of concern.

**Occupational risks to handlers are not of concern when products are used according to the label directions.**

No risks of concern were identified for workers involved in mixing, loading, applying, and handling product, when modern engineering and/or personal protective equipment are in place.

**Postapplication risks are not of concern when products are used according to the label directions.**

No risks of concern were identified for workers involved in postapplication activities such as working in treated sites or handling treated seed if modern protective measures are used including closed cab equipment.

Based on the human health assessment, the PMRA is proposing updates to product labels for the protection of workers and bystanders to meet current health standards.

## **Value Considerations**

### **What is the Value of Imidacloprid?**

Imidacloprid is approved for use on a wide range of agricultural crops in the grains and oilseeds and horticultural sectors, although the amount actually being used on each crop varies considerably. For some crops it is the only approved insecticide for specific pests, whereas for most crops there are alternative insecticides approved for use. Further, it has value as a seed treatment due to the limited number of registered seed treatments to manage the same pest and site combinations. In addition, imidacloprid provides a pest management tool for important insect pests of trees when applied as a tree injection (for example emerald ash borer).

With respect to alternatives, there are new insecticides that have been submitted for approval by manufacturers that may serve as replacements in some cases, or approved insecticides that may be expanded for use. Some of these insecticide alternatives may have cost implications, be less effective against specific pests, or be under re-evaluation themselves.

### **International Regulatory Status of Imidacloprid**

The PMRA routinely works collaboratively with other member countries in the Organisation for Economic Co-operation and Development (OECD) on the regulation of pesticides. As part of the re-evaluation of an active ingredient, the PMRA takes into consideration recent developments and new information on the status of a pesticide in other jurisdictions. Imidacloprid is currently acceptable for use in many OECD member countries, including Australia, New Zealand and the United States. Canada and the United States are collaborating on the re-evaluation of the neonicotinoids, including imidacloprid, to assess potential risks to pollinators.



In Europe, substantial use restrictions for imidacloprid (and other neonicotinoid products) have been imposed to minimize exposure to bees while an assessment of pollinator risk is completed.<sup>2</sup> Additional environmental risk assessment work continues in Europe. Provincial, state, and member state level restrictions on neonicotinoid use have been imposed in some cases.

## Next Steps

The PMRA is inviting the public to submit comments on the proposed re-evaluation decision for imidacloprid including proposals that may refine the risk assessment and risk management. Before making a final re-evaluation decision on imidacloprid, the PMRA will consider all comments received from the public in response to this consultation document. The PMRA will then publish a Re-evaluation Decision document, which will include the decision, the reasons for it, a summary of comments received on the proposed decision and the PMRA's response to these comments. Based on the final outcome of the re-evaluation, manufacturers will be expected to revise product labels to include new risk-reduction measures and/or phase-out uses according to the implementation schedule to be established by the PMRA.

<sup>2</sup>

Official Journal of the European Union, Commission Implementing Regulation (EU) No 485/2013 of 24 May 2013 amending Implementing Regulation (EU) No 540/2011, as regards the conditions of approval of the active substances clothianidin, thiamethoxam and imidacloprid, and prohibiting the use and sale of seeds treated with plant protection products containing those active substances, L 139/12, 25 May 2013. <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013R0485&from=EN>, accessed 26 October 2016.

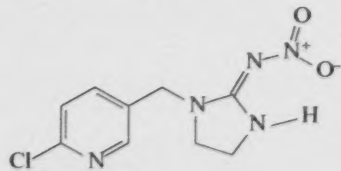
## Science Evaluation

### 1.0 Introduction

Imidacloprid is under re-evaluation in Canada as announced by the Pest Management Regulatory Agency (PMRA) on 1 April 2009. Imidacloprid is a broad spectrum insecticide belonging to Insecticide Resistance Action Committee (IRAC) Mode of Action (MoA) group 4A insecticide which acts as an agonist by binding to postsynaptic nicotinic receptors in the insect central nervous system. It works as a systemic insecticide with translaminar activity with contact and stomach action. Imidacloprid is readily taken up by plants by their roots and is further distributed upwards within the plant. Following the re-evaluation announcement for imidacloprid, the registrants of the technical grade active ingredient indicated their support to continue registration of all uses included on the labels of end-use products containing imidacloprid.

### 2.0 The Technical Grade Active Ingredient, Its Properties and Uses

#### 2.1 Identity of the Technical Grade Active Ingredient

|                                                                    |                                                                                      |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Common name</b>                                                 | Imidacloprid                                                                         |
| <b>Function</b>                                                    | Insecticide                                                                          |
| <b>Chemical Family</b>                                             | Neonicotinoid                                                                        |
| <b>Chemical name</b>                                               |                                                                                      |
| 1 <b>International Union of Pure and Applied Chemistry (IUPAC)</b> | (2 <i>E</i> )-1-[(6-chloropyridin-3-yl)methyl]- <i>N</i> -nitroimidazolidin-2-imine  |
| 2 <b>Chemical Abstracts Service (CAS)</b>                          | (2 <i>E</i> )-1-[(6-chloro-3-pyridinyl)methyl]- <i>N</i> -nitro-2-imidazolidinimine  |
| <b>CAS Registry Number</b>                                         | 138261-41-3                                                                          |
| <b>Molecular Formula</b>                                           | C <sub>9</sub> H <sub>10</sub> ClN <sub>5</sub> O <sub>2</sub>                       |
| <b>Structural Formula</b>                                          |  |
| <b>Molecular Weight</b>                                            | 255.7                                                                                |

| Registration Number | Purity (%) |
|---------------------|------------|
| 24468               | 98         |
| 30374               | 98.3       |
| 28936               | 98         |

## 2.2 Physical and Chemical Properties of the Technical Grade Active Ingredient

| Property                                      | Result                                                                                                                                                                                                                                                      |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour pressure at 25°C                       | $9 \times 10^{-7}$ mPa                                                                                                                                                                                                                                      |
| Ultraviolet (UV) / visible spectrum           | $\text{pH}$ $\lambda_{\text{max}}$ (nm)<br>4,7,9    270                                                                                                                                                                                                     |
| Solubility in water at 20°C                   | 610 mg/L                                                                                                                                                                                                                                                    |
| n-Octanol/water partition coefficient at 21°C | $\log K_{ow} = 0.57$                                                                                                                                                                                                                                        |
| Dissociation constant                         | The test substance shows very weak basic properties. Complete protonation can be achieved only in non-aqueous solvents in presence of very strong acids. It is not possible to specify a $\text{p}K_a$ value of the test substance in pure aqueous systems. |

## 2.3 Description of Registered Imidacloprid Uses

Appendix I lists all imidacloprid products that are registered under the authority of the *Pest Control Products Act* as of 15 August 2016. Appendix IIa lists all Commercial Class uses for which imidacloprid is registered, while Appendix IIb lists all Domestic Class uses for which imidacloprid is registered. All uses were supported by the registrant at the time of re-evaluation initiation and were therefore considered in the health and environmental risk assessments of imidacloprid.

## 3.0 Impact on Human Health

### 3.1 Toxicological Summary

A detailed review of the toxicological database for imidacloprid was conducted. The database is complete, consisting of the full array of toxicity studies currently required for hazard assessment purposes. The studies were carried out in accordance with currently accepted international testing protocols and Good Laboratory Practices. The database also included several studies conducted with various metabolites of imidacloprid. The database was supplemented by numerous publications from the scientific literature. Overall, the scientific quality of the data is high and the database is considered adequate to define the majority of toxic effects that may result from exposure to this pesticide.

In guideline metabolism studies in rats, methylene- $^{14}\text{C}$  imidacloprid and imidazolidine-4,5- $^{14}\text{C}$  imidacloprid were rapidly absorbed (peak plasma concentration 1-2.5 hours and 1-4 hours post-dosing, respectively) following oral exposure, with approximately 90% of the administered dose

(AD) being eliminated within 24 hours. Published in vitro data with human intestinal CaCo-2 cells demonstrated that imidacloprid crosses the transepithelial layer very quickly and completely with absorption facilitated by active transport. Urinary excretion was the major route of elimination (70-91% of the AD) in the guideline studies, with a lesser amount eliminated in feces (7-25% of the AD). Biliary excretion was an important contributor to fecal excretion as it accounted for 87% of fecal radioactivity. Only a trace amount was excreted in expired air. Total tissue burden 48 hours after dosing accounted for  $\leq 1\%$  of the AD. Tissues with the highest concentrations included liver, kidney, lung, skin and plasma with lesser amounts seen in the brain. No significant differences were noted between sexes, dose levels, or routes of administration in the guideline studies. In dogs dermally-treated with a single dose of an imidacloprid-containing formulation, peak imidacloprid residues were detected in blood at the first measured timepoint of 24 hours after application, with rapid dissipation such that residues were not detected after one week.

In addition to the parent, metabolites were identified in rat urine, including the glycine conjugate of 6-chloronicotinic acid,<sup>3</sup> 4-hydroxy-imidacloprid,<sup>4</sup> 5-hydroxy-imidacloprid,<sup>5</sup> dehydro-imidacloprid<sup>6</sup> (olefinic metabolite), 6-chloronicotinic acid,<sup>7</sup> the glycine conjugate of 6-S-methylnicotinic acid, nitroiminodehydroimidazolidine<sup>8</sup> and nitroiminoimidazolidine.<sup>9</sup> Desnitro-imidacloprid<sup>10</sup> was also identified in the feces. Nitrosimine-imidacloprid<sup>11</sup> was not detected as a biotransformation product in the standard rat metabolism study conducted with imidacloprid but was detected in the urine of rats fed a diet containing 1800 ppm of imidacloprid for one year. It should be noted that nitrosimine-imidacloprid can tautomerize to the nitrosamine form. A metabolism study conducted with nitrosimine-imidacloprid revealed a similar pattern of absorption and excretion when compared to imidacloprid, although imidacloprid tended to accumulate in tissues to a greater extent than did the nitrosimine metabolite.

Published data demonstrate that rats given a single oral dose of imidacloprid exhibited a slightly longer time to peak concentration (12 hours) in monitored compartments than that identified in guideline studies; two metabolites (6-chloronicotinic acid and 6-hydroxynicotinic acid) also showed a peak at 12 hours. Consistent with previous findings, peak levels of imidacloprid in blood exceeded those in brain in this study; a similar pattern was observed with tissue levels of 6-chloronicotinic acid and 6-hydroxynicotinic acid. Following intraperitoneal exposure in mice, metabolites from nitroreduction (i.e., nitrosimine-imidacloprid and desnitro-imidacloprid) and oxidative pathways were present in brain, liver and plasma. Mice deficient in aldehyde oxidase (AOX) had low levels of nitrosimine-imidacloprid and desnitro-imidacloprid in the liver, suggesting a key role for this enzyme in metabolism. In vitro data in human P450 supersomes indicated that certain CYP isoenzymes (CYP1A2, CYP2B6, CYP2D6 and CYP2E1) are also

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<sup>3</sup> Also known as WAK 3853

<sup>4</sup> Also known as WAK 4103 or M2

<sup>5</sup> Also known as M1

<sup>6</sup> Also known as NTN 35884 or M6

<sup>7</sup> Also known as M14

<sup>8</sup> Also known as KNO 0523

<sup>9</sup> Also known as NTN 33968 or KNO 0524

<sup>10</sup> Also known as NTN 33823 or NTN 38014 or M9

<sup>11</sup> Also known as WAK 3839 or M7



selective for the nitroreduction pathway. Significant species differences in the imidacloprid nitroreductive activity of liver cytosol were seen in vitro with levels of metabolite formation in rabbits > humans and rats > mice > dogs and cats. Human P450 supersome preparations further indicated that CYP3A4 is selective for imidazolidine oxidation.

Collectively, the metabolism data indicate two major routes of biotransformation. The first route involves hydroxylation of the imidazolidine ring by CYP3A4 to form 4-hydroxy and 5-hydroxy metabolites. These metabolites may form dihydroxy-imidacloprid, undergo glucuronidation or lose water to form the olefin metabolite. Oxidative cleavage of the 5-hydroxy metabolite yields 6-chloronicotinic acid. The second route involves nitro-reduction by either microsomal P450 enzymes or AOX to yield nitrosimine, amino-guanidine derivatives and desnitro-imidacloprid. Desnitro-imidacloprid undergoes oxidative cleavage to imidazolidine and 6-chloronicotinic acid. The 6-chloronicotinic acid from both pathways is subject to further glutathione conjugation. Results from acute studies indicate that technical imidacloprid was highly toxic by the oral route and of low toxicity by the dermal and inhalation routes in rats. Clinical signs noted in the acute oral and inhalation studies included decreased motility, labored breathing, piloerection and transient tremors. Additional signs noted in the acute oral studies included apathy, staggering gait and spasms. Imidacloprid was minimally irritating to rabbit eyes and skin and did not show sensitizing potential in the maximization assay in guinea pigs.

Acute oral toxicity studies on the urea and olefin metabolites of imidacloprid found them to be of slight toxicity to rats. The metabolites desnitro-imidacloprid and nitrosimine-imidacloprid were of high acute toxicity to rats; desnitro-imidacloprid was slightly more toxic than imidacloprid. Clinical signs in all of these studies were indicative of neurotoxicity.

In a short-term dietary study with imidacloprid in rats, changes in clinical chemistry and histology indicative of liver injury were noted. Published short-term studies conducted with imidacloprid in rats via gavage also identified the liver as a target organ but at lower dose levels than the dietary study. Imidacloprid administration to rats and dogs caused increases in liver metabolic enzymes (mixed function oxidase and/or cytochrome P450). The effect on metabolic enzymes was not considered adverse. Administration of the metabolite nitrosimine-imidacloprid to rats via drinking water in a short-term study did not identify hepatic toxicity but instead produced effects on white blood cells and non-specific organ weight changes; this metabolite was not considered to be more toxic than imidacloprid. Liver effects were also noted in rats in a 28-day inhalation toxicity study. A 21-day dermal toxicity study in rabbits afforded no evidence of toxicity up to the limit dose.

Effects on the kidney and eye, as well as microscopic lesions of the thyroid, were noted in the rat chronic dietary toxicity study. These microscopic lesions were described as mineralized particles in the colloid of isolated follicles and were not associated with changes in thyroid hormone levels. In the mouse dietary oncogenicity study, the main effects of imidacloprid consisted of reduced body weight, food consumption and water intake. There was no significant increase in toxicity observed with increased duration of dosing with imidacloprid. Neither the dietary carcinogenicity study in the rat nor the mouse dietary oncogenicity study provided evidence that imidacloprid was carcinogenic.

Most genotoxicity assays conducted with imidacloprid yielded negative results. Only two out of 13 registrant-conducted assays were positive and consisted of in vitro cytogenic assays conducted with human lymphocytes (clastogenicity) and Chinese hamster ovary cells (sister chromatid exchanges). No positive findings were noted in the in vivo assays. A published study showed negative results with imidacloprid in two in vitro assays in human lymphocytes (micronucleus and sister chromatid exchange assays). In the same publication, a positive result was demonstrated in an in vivo micronucleus assay in rats but only at a very high dose; negative results were noted at lower dose levels. The overall weight of evidence for imidacloprid did not suggest that it was genotoxic.

Reverse mutation assays with the urea and olefin metabolites of imidacloprid, desnitro-imidacloprid and nitrosimine-imidacloprid were negative. An additional ten genotoxicity studies (in vitro and in vivo) on nitrosimine-imidacloprid were also negative.

The dietary reproduction study in rats provided no evidence that imidacloprid was a reproductive toxicant. In that study, only reductions in body weight gains in parental animals (prematuring) and pups (during lactation) were noted. A published 60-day gavage study in rats noted disturbed estrous cyclicity; this study however, was conducted with formulated imidacloprid, and thus it is uncertain if these effects were attributable solely to imidacloprid. A 90-day published study in rats with imidacloprid, also by the gavage route, identified increased FSH, decreased LH and progesterone levels and decreased relative ovary weights only at the highest dose tested; this dose also produced clear signs of neurotoxicity and hepatotoxicity as well as evidence of lipid peroxidation and oxidative stress in the ovary.

A battery of studies performed for the United States. Endocrine Disruption Screening Program was negative for effects on the estrogen or androgen hormonal pathway or the steroidogenic pathway, however hormone levels were not measured directly in the in vivo studies. Overall there is a low level of concern for effects on hormones or endocrine organs as the findings only occurred at doses in the presence of other markers of toxicity.

In a rabbit gavage developmental toxicity study with imidacloprid, mortality and reduced body weight, body weight gain and food consumption were noted in dams. Increased abortions and total litter resorptions, decreased fetal weight and a slight increase in skeletal alterations were also noted at doses that caused significant maternal toxicity (in other words, mortality, body weight loss). In a rat gavage developmental toxicity study with imidacloprid, dams had decreased body weight gains while in fetuses there was a slight increase in the incidence of wavy ribs at a maternally-toxic dose. Results of the reproduction and developmental toxicity studies did not provide evidence of increased sensitivity in young.

Results of acute neurotoxicity testing showed that imidacloprid induced tremors, gait abnormalities, and righting reflex impairments as well as reductions in grip strength, response to stimuli, body temperature and motor/locomotor activity; reduced motor and locomotor activity was noted in females at the lowest dose tested. Reduced grip strength was also noted in male rats in the subchronic neurotoxicity study. Clinical signs of neurotoxicity (in other words, trembling

and severe tremors) were noted early in a 90-day oral dog study but were not observed at all in a 12-month oral dog study, where higher doses were used. The discrepancy between the findings in these two studies was attributed to the different type of feed in which imidacloprid was admixed prior to administration. Despite this discrepancy, the dog appeared to be the species most sensitive overall to the toxic effects of imidacloprid. Inconsistent effects on brain cholinesterase were seen in several imidacloprid studies; the significance of these alterations was not clear.

Neonicotinoid insecticides bind to nicotinic acetylcholine receptors (nAChRs) and, similar to nicotine, mimic the action of acetylcholine by opening the ion channels in the central and peripheral nervous system to allow sodium and calcium into cells. Activation of the receptors causes initial nervous stimulation but high and prolonged levels of activation can lead to blockage of the receptors. Whereas nicotine is selective for mammalian nAChR due to its ionized state, neonicotinoids are selective for insect nAChRs. Notwithstanding this generality, a number of published papers confirm that imidacloprid does affect mammalian nAChR in vitro with differences noted depending on the nAChR subtype. Imidacloprid demonstrated weak nAChR agonist activity in electrophysiological studies with mouse cochlear nucleus cells and human embryonic kidney cells stably expressing human  $\alpha 4 \beta 2$  receptors. Low affinity was seen for imidacloprid for the  $\alpha 1$  subtype in the electric organ of a Torpedo electric ray and for the  $\alpha 3$  and  $\alpha 7$  subtypes in human neuroblastoma cells. While the receptor studies collectively indicated weak activity for imidacloprid, desnitro-imidacloprid was shown to have more biological activity. Whereas nicotine binding with imidacloprid and its olefin metabolite was much greater in houseflies than in mouse brain membranes, desnitro-imidacloprid demonstrated selective activity in the mouse brain membrane.

The high affinity and potency of desnitro-imidacloprid was confirmed in mouse fibroblast cells stably transfected with  $\alpha 4 \beta 2$  receptors; affinity and potency of this metabolite were comparable to nicotine. Desnitro-imidacloprid was shown to activate the extracellular signal-related kinase cascade via interaction with neuronal  $\alpha 4 \beta 2$  receptors in mouse neuroblast cells with a similar potency as nicotine.

In addition to normal neurological function, nAChRs play a key role in neurodevelopment. In one published study, cultured cerebellar granule cells from neonatal rats (expressing  $\alpha 3$ ,  $\alpha 4$  and  $\alpha 7$  subtypes) were exposed to low concentrations of imidacloprid. Intracellular calcium mobilization suggested agonist activity however the neurons were likely fully differentiated at the time of the measures due to the prolonged duration of cell culture. Accordingly, the result is more relevant to adult neurotoxicity than developmental neurotoxicity. In another paper, offspring from rats exposed to a high dose of imidacloprid on a single day of gestation via the intraperitoneal route demonstrated decreased sensorimotor performance. Increased ligand binding for the muscarinic acetylcholine receptor (m2mAChR) was observed in these offspring but no effect was apparent on  $\alpha 4 \beta 2$  nAChR. In a registrant-conducted developmental neurotoxicity study, decreases in locomotor activity and in the thickness of caudate/putamen as well as impaired learning on one trial in the water maze test were noted in offspring at the highest dose level tested. This dose level produced effects on body weight and food consumption in the maternal animals. A no observed adverse effect level (NOAEL) for the reduced caudate/putamen width was not



established as morphometric assessments were not performed on offspring from the low and mid dose groups. The level of concern for the missing information was low since there was no indication of adverse functional changes in the young at the low and mid dose levels and the magnitude of the change in the caudate/putamen width was small (2-5%). As previously noted, this effect occurred at a dose level that was toxic to maternal animals.

Additional effects noted with imidacloprid in published papers included lipid peroxidation in liver and kidney tissue and evidence of oxidative stress in rat liver and brain tissue following repeated oral exposure. Increased lipid peroxidation and markers of oxidative stress were also seen with acute oral and intravenous exposure to imidacloprid in rats. Inflammatory changes in brain and liver were seen following acute intravenous imidacloprid exposure in rats.

Case reports of intentional exposures (in other words, suicides) to imidacloprid indicate that symptoms in humans consist of nausea, vomiting, headache, dizziness, abdominal pain and diarrhea. In one published paper, 56 patients reported symptoms of which 28 patients had plasma concentrations ranging from 0.02 to 51 ng/L (median 10.6 ng/L); recovery was seen in all 56 patients reported. Several case reports were available in which the patients died of cardiac complications following imidacloprid ingestion; in some of these cases, pre-existing cardiovascular disease may have been a contributing factor. In contrast to observations in some of the animal toxicity studies, cholinesterase activity was normal in these patients.

Changes were made to the manufacturing process of the technical grade active ingredient after the majority of the toxicological testing was conducted for imidacloprid. The technical imidacloprid produced by the revised manufacturing process, termed "AMP-W", was found to be negative in the bacterial reverse mutation assay, but two of its impurities, N-[(6-chloro-3-pyridinyl)methyl]-1,2-ethanediamine (PEDA) and N, N'-bis-[6-chloro-3-pyridinyl methyl]-1,2-ethanediamine (DIPEDA), tested positive. As the impurities were detected at trace levels (<0.1% w/w) in the technical grade active ingredient, they were not considered of toxicological concern.

Overall consideration of the toxicity of the imidacloprid mammalian metabolites indicates a low degree of concern for most of the tested compounds as they were less toxic than the parent compound. An exception to this finding involved the metabolite desnitro-imidacloprid. In vitro data suggested that this metabolite was bioactive, affecting mammalian nAChR in a manner akin to nicotine. This activity is a result of protonation of desnitro-imidacloprid under the conditions of physiological pH which in turn raises its affinity for mammalian nAChR. Desnitro-imidacloprid was more acutely toxic than imidacloprid via the oral route although the difference was only 1.4 – 2.3-fold. Guideline metabolism studies indicate this metabolite was only seen in the feces at low levels suggesting either little conversion to this metabolite in the rat or a transient presence of the metabolite. The only in vivo data that demonstrated the presence of desnitro-imidacloprid in the brain came from a study conducted via a route of low relevance to human risk assessment (intraperitoneal). In light of the above, the potential risk to mammals from desnitro-imidacloprid is likely addressed by the risk assessment for imidacloprid.



Results of the tests conducted on laboratory animals with imidacloprid and its metabolites, along with the toxicology endpoints for use in the human health risk assessment, are summarized in Tables 1 and 2 of Appendix III.

### **3.1.1 *Pest Control Products Act* Hazard Characterization**

For assessing risks from potential residues in food or from products used in or around homes or schools, the *Pest Control Products Act* requires the application of an additional 10-fold factor, known as the PCPA factor, to take into account potential prenatal and postnatal toxicity and completeness of the data with respect to the exposure of and toxicity to infants and children. A different factor may be determined to be appropriate on the basis of reliable scientific data.

With respect to the completeness of the toxicity database as it pertains to the exposure of and toxicity to infants and children, the database contains the full complement of required studies including a multigeneration reproduction study in the rat, developmental toxicity studies in the rat and rabbit, and a developmental neurotoxicity study in the rat.

With respect to identified concerns relevant to the assessment of risk to infants and children, there was no indication of increased susceptibility in the offspring compared to parental animals in the reproduction study. In the prenatal developmental toxicity studies in rats and rabbits, developmental effects included abortions, resorptions and skeletal variations; however, these effects occurred in the presence of marked maternal toxicity (in other words, maternal deaths and body weight loss). Thus, the developmental toxicity studies provided no indication of increased susceptibility of rat or rabbit fetuses following in utero exposure to imidacloprid. In the developmental neurotoxicity study, decreases in locomotor activity and thickness of caudate/putamen as well as impaired learning on one trial in the water maze test were noted in offspring at the highest dose level tested. A NOAEL for the reduced caudate/putamen width was not established as morphometric assessments were not performed on offspring from the low and mid dose groups. However, the concern regarding the missing measurements was low considering that i) no effects occurred in the young at lower dose levels (in particular there was no indication of adverse functional changes in the young at the low and mid dose levels); ii) the magnitude of the change in caudate/putamen width was small (2-5%); and iii) this effect occurred at a dose level that was toxic to maternal animals. Furthermore, the toxicological endpoints selected for risk assessment were considered protective of the slight brain morphometric changes. Therefore, the overall concern for this effect is low. On the basis of all the above information, the PCPA factor was reduced to 1-fold.

### **3.2 Dietary Exposure and Risk Assessment**

In a dietary exposure assessment, the PMRA determines how much of a pesticide residue, including residues in milk and meat, may be ingested with the daily diet. Exposure to imidacloprid from potentially treated imported foods is also included in the assessment. These dietary assessments are age specific and incorporate the different eating habits of the population at various stages of life (infants, children, adolescents, adults and seniors). For example, the assessments take into account differences in children's eating patterns, such as food preferences

and the greater consumption of food relative to their body weight when compared to adults. Dietary risk is then determined by the combination of the exposure and the toxicity assessments. High toxicity may not indicate high risk if the exposure is low. Similarly, there may be risk from a pesticide with low toxicity if the exposure is high.

The PMRA considers limiting use of a pesticide when risk exceeds 100% of the reference dose. PMRA's Science Policy Note *SPN2003-03, Assessing Exposure from Pesticides, A User's Guide*, presents detailed acute and chronic risk assessments procedures.

Residue estimates used in the dietary risk assessment may be based conservatively (using upperbound estimates) on the maximum residue limits (MRLs) or the field trial data representing the residues that may remain on food after treatment at the maximum label rate. Surveillance data representative of the national food supply may also be used to derive a more accurate estimate of residues that may remain on food when it is purchased. These include the Canadian Food Inspection Agency's National Chemical Residue Monitoring Program and the United States Department of Agriculture's Pesticide Data Program. Theoretical and experimental processing factors as well as specific information regarding percent of crops treated may also be incorporated to the greatest extent possible.

Acute and chronic exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model – Food Commodity Intake Database™ (DEEM-FCID™; Version 3.16) program, which incorporates food consumption data from the National Health and Nutrition Examination Survey/"What We Eat in America" (NHANES/WWEIA) dietary survey for the years 2003-2008. For more information on dietary risk estimates or residue chemistry information used in the dietary assessment, see Appendices IV and V.

### 3.2.1 Determination of Acute Reference Dose (ARfD)

The NOAEL of 8 mg/kg bw/day from the 90-day dietary study in the dog was selected. At the LOAEL of 22 mg/kg bw/day, clinical signs of neurotoxicity (trembling) were observed during the first week of dosing, as was slight emaciation. The standard uncertainty factor of 100-fold (10-fold to account for interspecies extrapolation and 10-fold to account for intraspecies variability) was applied. As described in the *Pest Control Products Acts Hazard Characterization* section, the PCPA factor was reduced to 1-fold. Therefore, the Composite Assessment Factor (CAF) was 100-fold.

The ARfD is calculated according to the following formula:

$$\text{ARfD} = \frac{\text{NOAEL}}{\text{CAF}} = \frac{8 \text{ mg/kg bw/day}}{100} = 0.08 \text{ mg/kg bw of imidacloprid}$$

The ARfD provides a margin of 250 to the reduced motor and locomotor activity noted at the LOAEL of 20 mg/kg bw in the acute neurotoxicity study in the rat.

### 3.2.2 Acute Dietary Exposure and Risk Assessment

The acute dietary risk (food and drinking water) was calculated considering the highest ingestion of imidacloprid that would be likely on any one day, and using food consumption and food residue values. The expected intake of residues is compared to the ARfD, which is the dose at which an individual could be exposed on any given day and expect no adverse health effects. When the expected intake of residues is less than the ARfD, then acute dietary exposure is not of concern.

The acute exposure assessments were conducted for the general population and all subpopulations by using Canadian MRLs, US Tolerances, CODEX MRLs or the maximum residue level from field trial data. Theoretical and experimental processing factors were used where available, and all crops were assumed to have been 100% treated, including imports. Drinking water contribution to the exposure was accounted for by direct incorporation of the estimated environmental concentration (EEC) obtained from water modelling (see Section 3.3), into the dietary exposure evaluation model (DEEM).

The acute exposure estimates at the 95<sup>th</sup> percentile for the general population and all subpopulations range from 15% to 54% of the ARfD, and therefore are not of concern.

### 3.2.3 Determination of Acceptable Daily Intake (ADI)

The NOAEL of 5.7 mg/kg bw/day from the 2-year dietary study in the rat was selected. At the LOAEL of 17 mg/kg bw/day, an increased incidence of mineralized particles in the colloid of isolated thyroid follicles was observed in males. The standard uncertainty factor of 100-fold (10-fold to account for interspecies extrapolation and 10-fold to account for intraspecies variability) was applied. As described in the *Pest Control Products Act* Hazard Characterization section, the PCPA factor was reduced to 1-fold. Therefore, the Composite Assessment Factor (CAF) was 100-fold.

The ADI is calculated according to the following formula:

$$\text{ADI} = \frac{\text{NOAEL}}{\text{CAF}} = \frac{5.7 \text{ mg/kg bw/day}}{100} = 0.06 \text{ mg/kg bw/day of imidacloprid}$$

The ADI provides a margin of at least 300 to the decreased motor and locomotor activity noted at 20 mg/kg bw in the rat acute neurotoxicity study and for severe effects (in other words, mortality, abortions, litter resorption) observed at the high dose of 72 mg/kg bw/day, a maternally-toxic dose, in the rabbit developmental toxicity study. A margin of 1000 exists between the ADI and the dose at which brain morphometric changes were noted in the DNT study (55-58 mg/kg bw/day).

### 3.2.4 Chronic Dietary Exposure and Risk Assessment

The chronic dietary risk (food and drinking water) was calculated by using the average consumption of different foods and drinking water, and the average residue values on those

foods and drinking water. This estimated exposure to imidacloprid was then compared to the ADI. The ADI is an estimate of the level of daily exposure to a pesticide residue that, over a lifetime, is believed to have no significant harmful effects. When the expected intake of residues is less than the ADI, then chronic dietary exposure is not of concern.

The chronic exposure assessments were conducted for the general population and all subpopulations by using Canadian MRLs, US Tolerances, CODEX MRLs or the median residue level from field trial data. Theoretical and experimental processing factors were used where available, and all crops were assumed to have been 100% treated, including imports. Drinking water contribution to the exposure was accounted for by direct incorporation of water monitoring data (see Section 3.3) into DEEM.

The chronic exposure estimates for the general population and all subpopulations range from 4% to 18% of the ADI, and therefore are not of concern.

### **3.3 Exposure from Drinking Water**

Residues of imidacloprid and its metabolites, imidacloprid-guanidine and imidacloprid-urea, in potential drinking water sources were estimated from modelling and used in the acute assessment while water monitoring data were used in the chronic assessment.

#### **3.3.1 Concentrations in Drinking Water**

Estimated environmental concentrations (EECs) for the combined residues of imidacloprid and its transformation products, imidacloprid-guanidine and imidacloprid-urea in potential sources of drinking water were calculated using the Surface Water Concentration Calculator model on a standard Level 1 scenario for a small reservoir. EECs in groundwater were calculated using the Pesticide Root Zone Model for Ground Water model. All scenarios were run using 50-year weather data. The daily surface water EEC (51 µg/L) was used for the acute dietary risk assessment of imidacloprid and its transformation products in drinking water. The maximum value from water monitoring data for imidacloprid and its metabolites expressed as imidacloprid equivalents (7.73 µg/L) was used as an estimate of potential concentrations in drinking water for the chronic dietary risk assessment. The EECs for drinking water are summarized in Table 1.



**Table 1 Estimated Environmental Concentrations of Imidacloprid Combined Residue, Imidacloprid + Imidacloprid-Guanidine + Imidacloprid-Urea, in Potential Sources of Drinking Water**

| Source                                              | Groundwater EECs<br>(µg a.i./L)                                             |                     | Surface Water EECs<br>(µg a.i./L) |                     |
|-----------------------------------------------------|-----------------------------------------------------------------------------|---------------------|-----------------------------------|---------------------|
|                                                     | Daily <sup>1</sup>                                                          | Yearly <sup>2</sup> | Daily <sup>3</sup>                | Yearly <sup>4</sup> |
| Level 1 modelling for imidacloprid combined residue | 567                                                                         | 566                 | 51 <sup>(6)</sup>                 | 2.3                 |
| Monitoring data <sup>5,7</sup>                      | 7 (imidacloprid)<br>0.4 (imidacloprid-guanidine)<br>0.2 (imidacloprid-urea) |                     |                                   |                     |

Notes:

- 1 90<sup>th</sup> percentile of daily average concentrations
- 2 90<sup>th</sup> percentile of 365 day moving average concentrations
- 3 90<sup>th</sup> percentile of the peak concentrations from each year
- 4 90<sup>th</sup> percentile of yearly average concentrations
- 5 Highest detections in potential drinking water sourced by groundwater or surface water, based on monitoring data
- 6 Value recommended for use in acute risk assessment
- 7 Values recommended for use in chronic risk assessment

EEC values were incorporated into the food categories “water, direct, all sources” and “water, indirect, all sources”. For acute assessment, a value of 51 ppb was used while for the chronic assessment, a value of 7.73 ppb was used. To calculate the chronic value, a molecular weight conversion factor of parent/metabolite was applied to each metabolite in order to convert to imidacloprid equivalents. Molecular weights for imidacloprid and metabolites are:

- Imidacloprid (C<sub>9</sub>H<sub>10</sub>ClN<sub>5</sub>O<sub>2</sub>): 255.7 g/mol<sup>12</sup>
- Imidacloprid-guanidine (C<sub>9</sub>H<sub>11</sub>ClN<sub>4</sub>): 210.7 g/mol<sup>13</sup> (conversion factor of 1.21)
- Imidacloprid-urea (C<sub>9</sub>H<sub>10</sub>ClN<sub>3</sub>O): 211.7 g/mol<sup>14</sup> (conversion factor of 1.21)

The sum of imidacloprid, imidacloprid-guanidine and imidacloprid-urea, expressed as imidacloprid = 7 ppb + [0.4 ppb × (255.7/210.7)] + [0.2 ppb × (255.7/211.7)] = 7.73 ppb

### 3.3.2 Drinking Water Exposure and Risk Assessment

Drinking water exposure estimates were not calculated separately. They were incorporated directly in the dietary (food + drinking water) acute and chronic assessments. Please refer to Sections 3.2.2 and 3.2.4 for details.

<sup>12</sup> <http://pubchem.ncbi.nlm.nih.gov/compound/86418#section=Top>

<sup>13</sup> <http://pubchem.ncbi.nlm.nih.gov/compound/10130527#section=Top>

<sup>14</sup> <http://www.chemspider.com/Chemical-Structure.10248201.html>

### **3.4 Occupational and Non-Occupational Exposure and Risk Assessment**

Occupational and non-occupational risk is estimated by comparing potential exposures with the most relevant endpoint from toxicology studies to calculate a margin of exposure (MOE). This is compared to a target MOE incorporating uncertainty factors protective of the most sensitive subpopulation. If the calculated MOE is less than the target MOE, it does not necessarily mean that exposure will result in adverse effects, but mitigation measures to reduce risk would be required.

#### **3.4.1 Toxicology Endpoint Selection for Occupational and Non-Occupational Risk Assessment**

##### **Dermal, inhalation and incidental oral routes (all durations)**

For short-term dermal exposure assessments, the NOAEL of 8 mg/kg bw/day from the 90-day dietary study in the dog was selected. The NOAEL was based on clinical signs of neurotoxicity (trembling) and slight emaciation at the LOAEL of 22 mg/kg bw/day.

When compared to the rat, the dog was the species most sensitive to neurotoxic effects after short-term exposure. In oral neurotoxicity studies in the rat, effects on more detailed analyses of neurotoxicity (such as the functional observational battery (FOB), motor activity testing, and learning and memory) were noted but at higher doses than the clinical signs of trembling noted in the dog. Although no effects were observed up to the limit dose in a 21-day rabbit dermal toxicity study with imidacloprid, this study did not include any specific assessments for neurotoxicity, such as an FOB. As such, the 21-day dermal study in the rabbit was not considered suitable for use in the dermal risk assessment.

For short-term inhalation exposure assessments, the NOAEL of 8.4 mg/kg bw/day from the 28-day inhalation study in the rat was selected. The NOAEL was based on liver effects and increased coagulation time at the LOAEL of 51.8 mg/kg bw/day.

For intermediate-term dermal and inhalation exposure assessments, the NOAEL of 8 mg/kg bw/day from the 90-day dietary study in the dog was selected. As previously discussed, the dermal toxicity study conducted with rabbits was deemed unsuitable for use in the dermal risk assessment. The longest inhalation toxicity study available was the 28-day inhalation study in the rat.

As there was uncertainty as to whether toxicity increased with duration of dosing following inhalation exposure, the inhalation toxicity study was also deemed unsuitable for scenarios other than short-term. Accordingly, an oral study was used for risk assessment in lieu of appropriate route-specific studies.

For non-dietary (incidental oral) scenarios of short or intermediate duration, the NOAEL of 8 mg/kg bw/day from the 90-day dietary study in the dog was selected for risk assessment as the route and duration of study were deemed appropriate.

For long-term dermal and inhalation scenarios, the NOAEL of 5.7 mg/kg bw/day from the 2-year rat study was selected. At the LOAEL of 17 mg/kg bw/day, an increased incidence of mineralized particles in the colloid of isolated thyroid follicles was observed in males.

For all exposure scenarios (occupational and residential), routes (dermal, inhalation and non-dietary) and durations (short, intermediate and long), a target Margin of Exposure (MOE) of 100 to account for intraspecies variation and interspecies extrapolation is considered appropriate. The PCPA factor has been reduced to 1-fold for residential assessments.

The endpoints and target MOE selected for risk assessment provide adequate margins to other endpoints of concern, including the changes in brain morphometrics in rat offspring in the DNT study.

### **Dermal Absorption**

The dermal absorption value of 5% was used for imidacloprid based on an *in vivo* rat dermal absorption study (PMRA #1738839).

### **3.4.2 Occupational Exposure and Risk Assessment**

Workers can be exposed to imidacloprid through mixing, loading, or applying the pesticide, and when entering a treated site to conduct activities such as scouting and handling treated crops or seeds.

#### **Mixer, Loader, and Applicator Exposure and Risk Assessment**

The following scenarios were assessed:

- Mixing/loading of liquids and wettable powders.
- Applying liquids by open cab groundboom or airblast.
- Applying liquids by aircraft.
- Mixing, loading, and applying liquids or wettable powder with handheld, backpack, and handgun lawn sprayer equipment.
- Mixing, loading, and applying granules by push rotary spreader and belly grinder.
- Applying tree injections in forests and woodlots.
- Mixing, loading, and application of liquids for seed treatments to cereals, corn, legumes and oilseeds.
- Mixing, loading, and application of suspensions and dust to potato seed pieces.
- Loading and planting of treated seeds and seed pieces.

Farmers and commercial applicators may handle imidacloprid for short (< 30 days) to extended periods of time from spring through fall, depending on the crop and use site. Most applicators have the potential for short-term exposure. Custom applicators may treat a high number of fields and were considered to have intermediate-term exposure (in other words, up to several months).

Likewise, greenhouse crops and tree injections have the potential for longer application periods and intermediate exposure can occur. Therefore, short-intermediate term exposure and risk was determined for mixer, loader, and applicators.

Commercial application of imidacloprid to structures in the form of gels or pastes for bait stations, spot and crack/crevice treatment were evaluated qualitatively as the exposure is considered to be minimal to workers.

Mixer/loader and applicator exposure was estimated based on the following personal protective equipment (PPE) and engineering controls:

- Baseline PPE - long pants, long-sleeved shirts and chemical-resistant gloves (unless specified otherwise). For groundboom application, this scenario does not include gloves, as the data quality was better for non-gloved scenarios than gloved scenarios.
- Mid-Level PPE - coveralls over long pants, long-sleeved shirts and chemical-resistant gloves.
- Respirator - respirator with a NIOSH-Approved organic-vapour-removing cartridge with a prefilter approved for pesticides OR a NIOSH-Approved canister approved for pesticides.

No appropriate chemical-specific handler exposure data were available for imidacloprid; therefore, dermal and inhalation exposures were estimated using data from the Pesticide Handlers Exposure Database (PHED) Version 1.1, and the Agricultural Handler Exposure Task Force (AHETF).

The PHED is a compilation of generic mixer/loader/applicator passive dosimetry data with associated software which facilitates the generation of scenario-specific exposure estimates based on formulation type, application equipment, mix/load systems and level of personal protective equipment (PPE). In most cases, PHED did not contain appropriate data sets to estimate exposure to workers wearing coveralls, chemical-resistant coveralls or a respirator. This was estimated by incorporating a 75% clothing protection factor for coveralls, a 90% clothing protection factor for chemical-resistant coveralls, and a 90% protection factor for a respirator into the unit exposure values. Inhalation exposures were based on light inhalation rates (17 L/min) except for backpack applicator scenarios, which were based on moderate inhalation rates (27 L/min).

The unit exposures for the open cab airblast scenario were derived from the appropriate AHETF study. Inhalation unit exposures are based on light inhalation rates (17 L/min) unless otherwise stated.

Imidacloprid is registered for tree injection applications for which no PHED scenario exists. For this scenario, the mixing and loading (liquid) scenario was used to estimate exposure of preparing the solution and loading the cartridges. Applicator exposure is expected to be minimal as activities are conducted with a closed system. It was assumed that this scenario would be



protective of the preloaded paste cartridges scenario, as exposure during mixing and loading the liquid solution would be higher.

Imidacloprid is registered for seed and potato seed piece treatments. PHED scenarios were not considered to be representative of exposure to workers treating or handling seed or seed pieces. Surrogate commercial and on-farm seed treatment exposure studies, as well as exposure studies for planting treated seeds, were used to estimate worker exposure.

For most uses, calculated MOEs exceeded target MOEs and therefore risks are not of concern.

Tables 1- 3 of Appendix VI summarize the calculated MOEs for mixers/loader, applicators, and handlers.

For commercial seed treatment of canola and mustard, additional engineering controls (closed mix/load system, water soluble packaging) and personal protective equipment are required to meet the target MOEs. Applicators and baggers/sewers/stackers require chemical-resistant gloves and coveralls over a single layer. Cleaners require chemical-resistant gloves, coveralls over a single layer and a respirator.

For other commercial seed treatment uses, additional personal protective equipment (chemical-resistant gloves, coveralls over a single layer, and a respirator) is required for cleaners.

### **Postapplication Worker Exposure and Risk Assessment**

The postapplication occupational risk assessment considered exposures to workers who enter treated sites to conduct agronomic activities involving residue contact (for example, scouting, handling of treated seeds). Based on the imidacloprid use pattern, there is potential for short-intermediate term (< 6 months) postapplication exposure for most worker activities. There is potential for long term exposure involving soil contact in greenhouses (for example: after chemigation/drench scenarios) where transplant activities can occur year round.

Activity-specific transfer coefficients (TC) from the Agricultural Re-entry Task Force (ARTF) were used to estimate postapplication exposure resulting from contact with treated turf and foliage at various times after application. Dislodgeable foliar residue (DFR) and turf transferrable residues (TTR) refer to the amount of residue that can be dislodged or transferred from a surface, such as the leaves of a plant or turf. A TC is a factor that relates worker exposure to dislodgeable residues. TCs are specific to a given crop and activity combination (for example: hand harvesting apples, scouting late season corn) and reflect standard work clothing worn by adult workers. Postapplication exposure activities include (but are not limited to): scouting and mowing in turf, as well as hand harvesting, pinching, pruning, and thinning for ornamental and agricultural crops. For more information about estimating worker postapplication exposure, refer to PMRA's regulatory proposal PRO2014-02, Updated Agricultural Transfer Coefficients for Assessing Occupational Postapplication Exposure to Pesticides.

There were no chemical-specific DFR or TTR studies submitted to the PMRA for the re-evaluation of imidacloprid; therefore the following defaults were used:

- A default peak value of 25% of the application rate with a dissipation rate of 10% per day was used for DFR.
- A default peak value of 1% of the application rate with a dissipation rate of 10% per day was used for TTR.

PMRA's science policy note [SPN2014-02, Estimating Dislodgeable Foliar Residues and Turf Transferable Residues in Occupational and Residential Postapplication Assessments](#) presents further details on the derivation and use of these defaults for pesticide assessments.

For workers entering a treated site, restricted-entry intervals (REIs) are calculated to determine the minimum length of time required before people can safely enter after application. An REI is the duration of time that must elapse before residues decline to a level where performance of a specific activity results in exposures above the target MOE.

The PMRA is primarily concerned with the potential for dermal exposure for workers performing postapplication activities in crops treated with a foliar spray. Based on the vapour pressure of imidacloprid, inhalation exposure is not likely to be of concern provided that the minimum 12-hour REI is followed.

For pre-plant applications to soil, postapplication exposure was assessed using an approach outlined in the United States Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS) document for dermal exposure to soil.

Postapplication exposure from planting commercially treated and bagged seed using a closed cab planter was assessed. Calculated dermal and inhalation MOEs exceeded the target MOE and are not of concern. For seed treatment, the statement "Closed cabs must be used for planting commercially treated and bagged seeds." is proposed for labels and tags accompanying treated seeds. Postapplication exposure from planting on-farm treated seed and commercially treated bulk seed is addressed in the on-farm exposure studies.

Calculated dermal MOEs for all worker postapplication exposure scenarios exceeded target MOEs and are not of concern. REIs were set at the standard minimum value of 12 hours for all postapplication activities in agricultural areas. For turf use in residential areas and golf courses, the statement "Do not enter or allow others (for example: children, pets) to enter treated areas until sprays have dried" is proposed for labels.

The postapplication exposure assessment is outlined in Appendix VI, Tables 4 - 6. For guidance on REIs, please refer to the "Guidance for Federal/Provincial/Territorial Committee: Understanding Restricted-Entry Intervals for Pesticides", which is available from the PMRA upon request.

### **3.4.3 Non-Occupational Exposure and Risk Assessment**

Non-occupational risk assessment involves estimating risks to the general population, including youth and children, during or after pesticide application.

The United States Environmental Protection Agency (USEPA) has generated standard default assumptions and algorithms for developing residential exposure assessments for both applicator and postapplication exposures when chemical- and/or site-specific field data are limited. The assumptions may be used in the absence of, or as a supplement to, chemical- and/or site-specific data and generally result in high-end estimates of exposure. The assumptions and algorithms relevant to imidacloprid are outlined in the Standard Operating Procedures (SOPs) for Residential Pesticide Exposure Assessments 2012 under the following sections:

- Section 3: Lawns and Turf
- Section 7: Indoor Use
- Section 8: Treated Pets

### **Residential Handler Exposure and Risk Assessment**

A residential applicator refers to an adult who uses or applies a domestic-class imidacloprid product in outdoor environments or on pets. Residential applicators are assumed to be wearing shorts, short-sleeve shirts, shoes, and socks. Homeowners have the potential for short-term exposure (1-30 days) when applying products containing imidacloprid.

Based on typical use patterns, the major scenarios identified were:

- Applying liquid spot-on solutions to pet dogs and cats.
- Applying granular domestic products to turf.

Calculated dermal MOEs for residential handler exposure to imidacloprid exceeded target MOEs for all scenarios and are not of concern. The residential handler risk assessment is outlined in Appendix VII: Table 1.

Risk assessments for the application of imidacloprid to indoor environments were conducted qualitatively, as the exposure is considered to be low for baits and gel products. Inhalation exposure was assumed to be negligible for spot-on treatment to pets, based on the USEPA Residential SOPs (2012).

### **Residential Postapplication Exposure and Risk Assessment**

Residential postapplication exposure refers to an exposure scenario in which an individual is exposed through dermal, inhalation, and/or incidental oral (non-dietary ingestion) routes as a result of activities occurring in a residential environment that has been previously treated with a pesticide. The area could have been treated by a residential applicator using a domestic-class product or a commercial applicator hired to treat the residential area.

There is potential for short-intermediate term exposure to adults, youth (11 to <16 years old), and children (6 to <11 years old and 1 to <2 years old) through contact with residues following applications of imidacloprid to turf and lawns, as well as following applications of imidacloprid to pets. Adults, youth, and children have the potential for postapplication dermal exposure; children (1 to <2 years old) also have the potential for incidental oral exposure.

The following scenarios were assessed for postapplication exposure after residential use of products containing imidacloprid:

- Adult, youth, and children dermal exposure to turf treated by granule and wettable powder formulations used in a residential environment.
- Incidental oral exposure of children to turf treated by granule and wettable powder formulations in residential environments.
- Adult, youth, and children dermal exposure from spot-on applications to treated pets.
- Incidental oral exposure of children from spot-on applications to treated pets.

A quantitative postapplication dermal exposure assessment was not conducted for the indoor environment scenario as postapplication dermal exposure is expected to be low when formulations are packaged in bait stations and when gels/pastes are applied by professional applicators to areas “inaccessible to children” as stated on the labels.

A quantitative postapplication inhalation indoor and outdoor exposure assessment was not conducted as inhalation exposure is expected to be low due to the low vapour pressure of imidacloprid, as well as its packaging and formulation.

Postapplication dermal exposure using activity-specific TCs was calculated using estimates for treated surface residue (for example: foliage, turf, pet fur), surface-to-skin residue transfer for individuals contacting treated surfaces during certain activities, and exposure time. A TC is a factor that relates exposure to dislodgeable/transferable residues. It is an empirical measure of residue transferability from the treated surface (for example: foliage) onto a person's skin or clothing through contact while performing specific activities in a given period (usually expressed in units of  $\text{cm}^2$  per hour) and is specific to a particular population.

For the residential postapplication assessment, transfer coefficients from the US Residential SOPs 2012 were used for activities conducted on turf (for example: mowing and golfing) and for activities resulting in contact with pets.

Calculated MOEs for dermal and incidental oral residential postapplication exposure to imidacloprid exceeded target MOEs and therefore, risks are not of concern. The residential postapplication risk assessment is outlined in Appendix VII: Tables 2-8.



### **Dermal Bystander Exposure and Risk Assessment**

There is potential for short-term dermal exposure to imidacloprid for adults, youth, and children (6 to <11 years old) by entry into treated non-cropland areas for example: hiking through parks that have recently been treated with imidacloprid. This exposure is expected to minimal and the residential postapplication assessments for turf use would address this scenario.

### **3.5 Aggregate Exposure and Risk Assessment**

Aggregate exposure is the total exposure to a single pesticide that may occur from food, drinking water, residential and other non-occupational sources, and from all known or plausible exposure routes (oral, dermal, and inhalation).

#### **3.5.1 Toxicology Endpoint Selection for Aggregate Risk Assessment**

For short- and intermediate-term aggregate risk assessment, the NOAEL of 8 mg/kg bw/day from the 90-day dietary study in the dog was selected. At the LOAEL of 22 mg/kg bw/day, clinical signs of neurotoxicity (trembling) were observed during the first week of dosing, as was slight emaciation. These effects were considered relevant to all routes of exposure (oral, dermal and inhalation) and all sub-populations. Although liver toxicity was also a common endpoint across various routes of exposure, it was not selected for aggregation as the neurotoxicity endpoint was considered protective of liver effects. A target MOE of 100 to account for intraspecies variation and interspecies extrapolation is considered appropriate.

#### **3.5.2 Residential, Non-Occupational, and Dietary Aggregate Exposure and Risk Assessment**

In an aggregate risk assessment, the combined potential risk associated with food, drinking water and various residential exposure pathways is assessed. A major consideration is the likelihood of co-occurrences of exposure.

For imidacloprid, the following scenarios have the potential of co-occurrence on the same day:

##### **Adults:**

- Residential turf (granular) dermal and inhalation applicator + residential turf postapplication dermal + chronic dietary
- Residential turf (solution) postapplication dermal + chronic dietary
- Residential pet applicator dermal + postapplication pet dermal + chronic dietary

##### **Youth, and Children 6 to <11 years:**

- Residential turf (granular) postapplication dermal + chronic dietary
- Residential turf (solution) postapplication dermal + chronic dietary

Children 1 to <2 years:

- Postapplication pets dermal + pet hand-to-mouth incidental oral + chronic dietary
- Postapplication turf (liquid) dermal + turf hand-to-mouth incidental oral + chronic dietary
- Postapplication turf (granular) dermal + turf hand-to-mouth incidental oral + chronic dietary

Calculated aggregate MOEs exceeded target MOEs for all scenarios and therefore, risks are not of concern. The aggregate risk assessment is outlined in Appendix VIII, Table 1.

### **3.6 Cumulative Assessment**

The *Pest Control Products Act* requires the Agency to consider the cumulative effects of pest control products that have a common mechanism of toxicity. Imidacloprid belongs to a group of insecticides commonly known as the neonicotinoids. Upon completion of the re-evaluation of imidacloprid, it will be determined whether a cumulative effects assessment is necessary and if so, this will be performed with all relevant chemicals of the common mechanism group.

### **3.7 Incident Reports Related to Human Health**

As of September 15, 2016, there were 65 human incident reports<sup>15</sup>. Most human incidents occurred following the application of a flea and tick control product or contact with pets following treatment with these products. Almost all subjects experienced non-serious symptoms (predominantly rash, itchy skin, headache, dizziness, difficulty breathing, and throat irritation) consistent with those reported in toxicological and poisoning data for the active ingredient imidacloprid or the end-use product.

Spot-on products involved in Canadian incidents have precautionary statements to avoid exposure. Users are instructed to wear rubber gloves during application, to wash thoroughly, and contact with the pet is to be avoided until the product is dry. The review of human incidents did not impact the risk assessment.

## **4.0 Impact on the Environment**

The current environmental assessment considers all commercial uses of imidacloprid with the exception of tree injection uses. The environmental risk of imidacloprid resulting from tree injection uses was previously assessed by the PMRA with the publication of an evaluation report on July 22, 2011 (ERC2011-03: Confidor 200 SL containing imidacloprid), and further assessed with the publication of a proposed registration decision on July 19, 2016 (PRD2016-16, Imidacloprid).

An evaluation of available scientific information found that, under the approved conditions of use, tree injection uses of imidacloprid do not present a risk of concern to the environment.

<sup>15</sup>

Domestic animal incident reports involving imidacloprid (alone or in combination with other actives) are being reviewed as part of an evaluation involving all spot on products and thus, are not included in this re-evaluation.

#### 4.1 Fate and Behaviour in the Environment

Imidacloprid enters the terrestrial environment when it is used as an insecticide on a variety of grain, cereal, fruit and vegetable crops, turf, ornamental and vegetable plants grown in fields or in greenhouses and nurseries, and as a seed treatment for the control of a broad spectrum of insect pests. In the terrestrial environment, imidacloprid is expected to be moderately persistent to persistent under aerobic soil conditions (laboratory aerobic DT<sub>50</sub> values range from 157 to 973 days).

Imidacloprid-urea was identified as a major biotransformation product (>10%) under aerobic soil conditions; minor transformation products (<10%) included: imidacloprid-guanidine, imidacloprid-olefin, imidacloprid-nitrosimine, 6-chloronicotinic acid and 2,5-diketo-imidacloprid.

Imidacloprid has a low vapour pressure and is not expected to volatilize from moist soil or water surfaces (Henry's law constant =  $9.9 \times 10^{-13}$  atm·m<sup>3</sup>/mole).

Photolysis in soil is shown to range considerably (18 hours to 38.9 days based on continuous irradiation); the reason for the difference between studies is unclear but may be due to differing soil conditions (for example, soil moisture, adsorption to soil, light penetration into soil, microbial activity). A predicted environmental DT<sub>50</sub> value was reported in only one soil photolysis study (171 days based on midsummer sunlight at 40° latitude).

Imidacloprid demonstrates a medium to high potential for mobility in soil; the combination of low soil adsorption (K<sub>oc</sub> range: 41 - 1560) and high water solubility (510 mg/L) suggests a potential to reach ground water. Some of the transformation products of imidacloprid (i.e., imidacloprid-urea, imidacloprid-guanidine and imidacloprid-olefin) also demonstrate a medium to high potential to move through soil. When taking into consideration the criteria of Cohen *et al.* (1984) and the groundwater ubiquity score (GUS) it was determined that imidacloprid is likely to leach through soils. Soil column leaching experiments confirm that imidacloprid is capable of leaching through a variety of soils; aged soil column leaching experiments, however, reveal that adsorption of imidacloprid to soil increases with aging of the compound in soil. Terrestrial field studies show that the majority of applied imidacloprid remains in the top 30 cm of soil; residues are detected lower in the soil profile, albeit at concentrations very close to or below the limit of quantitation. Prospective groundwater studies (California and Michigan) confirm that small amounts of imidacloprid residues have the potential to migrate through the unsaturated shallow soil profile into groundwater. Imidacloprid residues have been detected in groundwater in Europe, Canada and the United States at concentrations approximately thirty fold higher than those recorded in prospective groundwater studies. Imidacloprid was detected in groundwater at levels as high as 7 µg/L in New York State, and 6.4 µg/L in a potato-growing area of Quebec.

Long-term field studies reveal that imidacloprid residues can carryover to the next growing season and increase in soil with each subsequent year of use until a plateau is reached (~ 3 years).

Imidacloprid can enter the aquatic environment through spray drift and run-off from the application site. Imidacloprid is highly soluble in water and hydrolysis is not an important route of transformation. Based on laboratory studies conducted in darkness, imidacloprid is slightly persistent to moderately persistent under aerobic conditions ( $DT_{50\text{whole system}} = 30 - 159$  days) and slightly persistent under anaerobic conditions ( $DT_{50} = 27$  days). In the presence of sunlight, however, imidacloprid is shown to transform in water at a much faster rate (i.e., aqueous photolysis  $DT_{50} = 0.2$  days; aquatic aerobic biotransformation exposed to sunlight  $DT_{50} < 5$  days). Aqueous phototransformation products include: imidacloprid-urea, imidacloprid-guanidine, 6-chloronicotinoic aldehyde, 6-chloro-N-methylnicotinacidamide and 6-chloro-3-pyridyl-methylethylenediamine and monohydroxy-imidacloprid. Laboratory experiments indicate that coloured components of the formulation as well as the presence of UV absorbing chemicals (for example, acetone) in natural waters may slow the rate of phototransformation. The majority of imidacloprid residues are shown to partition into the water phase. Mineralization is shown to be very slow under aerobic and anaerobic conditions ( $< 2\%$ ); mineralization increased slightly under aerobic conditions with exposure to light (6 – 10%). Imidacloprid-guanidine, a major biotransformation product ( $> 10\%$ ) was identified under aquatic conditions (aerobic and anaerobic). Minor transformation products ( $< 10\%$ ) included: monohydroxy-imidacloprid, 6-hydroxynicotinic acid, imidacloprid nitrosamine, imidacloprid-urea and 6-chloronicotinic acid. Aquatic field studies on the environmental fate of imidacloprid demonstrate that imidacloprid is non-persistent with half-lives ranging from 1.4 to 13 days in the water column (14.8 days whole system average). Residues in water and sediment, however, can remain detectable up to 7 weeks after the last application. Frequent detection in surface water monitoring programs are likely a result of the persistence of imidacloprid in soil (i.e., entering aquatic systems in runoff), its potential for mobility, as well as the scale of use. The intensity of use in the watershed affects levels of imidacloprid in water; higher intensity of use (based on percentage of a crop in the watershed) typically results in higher levels in water.

The log octanol/water partitioning coefficient for imidacloprid ( $\log K_{ow} = 0.57$ ) suggests a low potential for bioaccumulation in the food chain. Bioconcentration Factors (BCFs) for fish range from 0.97 to 3.7 L/kg. A Bioaccumulation Factor (BAF) of 7.35 is reported for the freshwater invertebrate *Gammarus pulex*; the depuration rate (11.2 days for elimination of 95% of steady state residues) indicates that bioaccumulation is short-lived.

Environmental fate data for imidacloprid and its transformation products are summarized in Tables 1a-1c of Appendix IX.

#### **4.2 Environmental Risk Characterization**

The environmental risk assessment integrates the environmental exposure and ecotoxicology information to estimate the potential for adverse effects on non-target species. This integration is achieved by comparing exposure concentrations with concentrations at which adverse effects occur. Estimated environmental exposure concentrations (EECs) are concentrations of pesticide in various environmental media, such as food, water, soil and air. The EECs are estimated using standard models which take into consideration the application rate(s), chemical properties and



environmental fate properties, including the dissipation of the pesticide between applications. Ecotoxicology information includes acute and chronic toxicity data for various organisms or groups of organisms from both terrestrial and aquatic habitats including invertebrates, vertebrates, and plants. Toxicity endpoints used in risk assessments may be adjusted to account for potential differences in species sensitivity as well as varying protection goals (i.e., protection at the community, population, or individual level).

Initially, a screening level risk assessment is performed to identify pesticides and/or specific uses that do not pose a risk to non-target organisms, and to identify those groups of organisms for which there may be a potential risk. The screening level risk assessment uses simple methods, conservative exposure scenarios (for example, direct application at a maximum cumulative application rate) and sensitive toxicity endpoints. A risk quotient (RQ) is calculated by dividing the exposure estimate by an appropriate toxicity value ( $RQ = \text{exposure/toxicity}$ ), and the risk quotient is then compared to the level of concern (LOC). If the screening level risk quotient is below the level of concern, the risk is considered negligible and no further risk characterization is necessary. If the screening level risk quotient is equal to or greater than the level of concern, then a refined risk assessment is performed to further characterize the risk. A refined assessment takes into consideration more realistic exposure scenarios (such as drift to non-target habitats) and might consider different toxicity endpoints. Refinements may include further characterization of risk based on exposure modelling, monitoring data, results from field or mesocosm studies, and probabilistic risk assessment methods. Refinements to the risk assessment may continue until the risk is adequately characterized or no further refinements are possible.

#### **4.2.1 Risks to Terrestrial Organisms**

A summary of terrestrial toxicity data for imidacloprid is presented in Appendix IX: Tables 2 to 8. For the assessment of risk, toxicity endpoints chosen from the most sensitive species were used as surrogates for the wide range of species that can be potentially exposed following treatment with imidacloprid. For birds, sufficient acute toxicity data were available to determine an  $HD_5$  (the 5th percentile of the species sensitivity distribution (SSD) for the  $LD_{50}$  at 50% confidence intervals); a summary of the SSD analysis is available in Appendix XI.

The terrestrial assessment took into account the range of agricultural application rates that are registered for imidacloprid, taking into consideration that there may be multiple applications of imidacloprid in a use season.

##### **Terrestrial Invertebrates**

###### **Soil dwelling invertebrates**

The lowest 14-day  $LC_{50}$  is 0.77 mg a.i./kg soil dw (*Eisenia foetida*). At the maximum single application rate (586.9 g a.i./ha), the calculated EEC in soil is 0.26 mg a.i./kg soil. The associated risk quotient based on the maximum application rate, ( $RQ < 0.34$ ) indicates that imidacloprid is not expected to pose an acute risk to earthworms.

On a chronic basis, laboratory studies show reduced reproductive potential (i.e., number of juveniles, eggs or cocoons), weight loss and feeding inhibition; the lowest chronic NOEC value for imidacloprid is 0.20 mg a.i./ha soil dw (*Folsomia candida*). The associated risk quotient based on the maximum single application rate is 1.3. Imidacloprid may pose a slight risk to earthworms at single application rates higher than 451 g a.i./ha; this value was derived by back calculation (i.e., maximum application rate – 586.9 g a.i./ha divided by the risk quotient – 1.3).

It should be noted that the highest maximum annual application rate (586.9 g a.i./ha – registered for use on crop group 9 – cucurbit vegetables) is applied to the ground via transplant water; imidacloprid may be applied as a concentrated band during or after planting of seedlings or as wet transplant plugs pre-treated with imidacloprid. As such, the area of highest concentration exposure will be near the bands of application or close to the transplant holes. Soil concentrations adjacent to the areas of application would be expected to become diluted to below levels that would elicit a chronic reproductive risk.

Higher tier risk assessments were conducted based on a weight of evidence approach. Field studies demonstrate no significant adverse effects on the abundance of earthworm populations from annual application of imidacloprid to winter barley seeds or annual application as a foliar spray in apple orchards for six consecutive years; 133 and 150 g a.i./ha, respectively). Decreases in earthworm populations have been observed after a single seasonal application at higher rates (340 – 450 g a.i./ha), however, this effect was transient; earthworm populations recovered within 36 – 40 days post application. In contrast, turf application (370 g a.i./ha) resulted in suppressed abundance of some soil-active arthropods (for example, Collembola, Hymenoptera) with no recovery within the same season of application or during a 5 year period of annual subsequent use. It should be noted that the highest turf rate registered in Canada is 281.25 g a.i./ha; uncertainty exists as to whether the same effects (i.e., suppressed abundance with no recovery within season or subsequent years of use) would manifest at the Canadian turf rate.

Overall, risks of concern are not expected for earthworms. Based on field studies, the risk of concern to other soil dwelling invertebrates from Canadian uses and application rates of imidacloprid cannot be excluded.

### **Honey bees**

A risk assessment for honey bees and other pollinators is not included in this document as PMRA is conducting a separate pollinator risk assessment for imidacloprid as part of a re-evaluation of a cluster of neonicotinoids (REV2012-02, *Re-evaluation of Neonicotinoid Insecticides*). A preliminary assessment for this re-evaluation was published for public consultation in January 2016 (REV2016-05, *Re-evaluation of Imidacloprid – Preliminary Pollinator Assessment*).

Comments were received from the public and are currently being incorporated into the imidacloprid pollinator assessment. As well, in 2014, PMRA required new restrictions on the use of corn and soybean seed treatment products containing imidacloprid to reduce pollinator exposure to pesticide containing dust generated when planting treated seeds.<sup>16</sup>

### Beneficial arthropods

The risk to beneficial arthropods (Appendix IX, Table 9) from exposure to direct application of imidacloprid was initially assessed using the most sensitive LR<sub>50</sub> for the parasitic wasp *A. rhopalosiphi*, 0.45 g a.i./ha (adults - extended laboratory test). The EECs were determined for both on-field and off-field exposure. The single lowest foliar spray application rate was used to estimate the environmental exposure concentration (EEC), Crop group 13B: Berry and small fruit – 42 g a.i./ha.

The imidacloprid EEC values for beneficial predatory and parasitic arthropods were refined to consider foliar interception. The exposure estimates are assuming deposition to a 2-dimensional structure. Therefore, the values can be corrected to take into account the 3-dimensional structure where a certain fraction is intercepted by the crop (for in-field exposure) or the off-field vegetation (for off-field exposure). For the in-field EEC, crop-specific foliar interception factors are applied to the application rate. For the off-field EEC, a vegetation distribution factor is applied to the application drift rate.

The calculated risk quotients for beneficial arthropods are shown in Table 9 (Appendix IX). The risk quotients exceed the LOC for beneficial arthropods at the lowest field application rate on field and off-field. Imidacloprid, therefore, is expected to pose a risk to beneficial arthropods at all application rates for foliar uses.

Higher tier risk assessments were conducted based on a weight of evidence approach. In extended laboratory aged residue tests, no significant effects on adult *A. rhopalosiphi* mortality or reproduction were observed after 14 days (apple leaves) and 21 days (tomato leaves) of residue aging after the 2<sup>nd</sup> application (2 × 100 g a.i./ha at 14d interval); these results suggest that recolonization after foliar application at this rate in apple orchards and tomato fields would be possible. However, in addition to the potential for recovery, different sensitivity of different life stages is an important consideration. For example, eggs (glassy winged sharpshooter – *H. vitripennis*) parasitized by the wasp *G. ashmeidi* ovipositioned onto imidacloprid treated cotton leaves showed no mortality to the developing embryo or parasite, however, significant mortality was observed after emergence (48 hour LD<sub>50</sub> = 39 and 66 ng a.i./cm<sup>2</sup> – equivalent to approximately 390 and 660 g a.i./ha, respectively).

Beneficial arthropods may also be exposed to imidacloprid via dietary contamination following foliar application or seed treatments (for example, predatory invertebrates that consume pests feeding on treated crops – aphids, feeding on nectar/pollen, guttation droplets of treated crops plants). The effectiveness of the parasitic wasp *Aphelinus certus* as a natural enemy of soybean

<sup>16</sup> [http://www.hc-sc.gc.ca/cps-spc/pubs/pest/fact-fiche/pollinator-protection-pollinisateurs/treated\\_seed-2014-senences\\_traitees-eng.php](http://www.hc-sc.gc.ca/cps-spc/pubs/pest/fact-fiche/pollinator-protection-pollinisateurs/treated_seed-2014-senences_traitees-eng.php)

aphid (*G. glycines*) is shown to be reduced in imidacloprid seed-treated crops. *A. certus* was able to parasitize soybean aphids feeding on seed-treated plants 5 weeks after planting, however, overall parasitism rates were reduced by 69-88% compared to the control group for up to 10 weeks after planting. Survival of larval and pupal stages of predatory coccinellid (*H. undecimnotata*) was reduced from feeding on aphids colonizing potted treated bean plants (i.e., 0.0355 mg a.i./pot – a rate equivalent to approximately 14 times lower than the recommended label rate – Confidor 20SC); adult fecundity of the survivors was reduced by 33%.

Adult parasitic wasp (*A. pseudococci*) was reduced to 38% after one day of feeding on nectar from treated buckwheat flowers (soil application at label rate, 6.6 ppm ~16 ppb/flower). The collective results of these studies indicate that a risk to arthropods cannot be excluded for seed treatment uses.

In higher tier studies (field), significant reductions in the abundance of several arthropod species are reported. For granular imidacloprid product application to turf (i.e., Merit 0.5G – 340 g a.i./ha), reduced abundance of arthropod species was observed within one year after application but not in the next year. In a field study that examined the effect of treated corn seed (4.9 g a.i./kg seed) sown for 5 consecutive seasons on arthropods, reduced abundance was noted for some species, albeit effects varied with the year of study.

The collective results of several laboratory toxicity tests indicate that imidacloprid may pose a risk to non-target arthropods in the in-field and off-field area. Based on limited field study results (turf and seed treatment), reduced abundance of arthropod species appears to be limited to within the same season of application. Consequently, a precautionary statement is required on imidacloprid product labels to inform users of the potential hazard to beneficial arthropods.

### Terrestrial Plants

In seedling emergence and vegetative vigour tests (Limit tests with both dicot (5) and monocot (6) crop species), no effects are observed at concentrations as high as 1000 g a.i./ha (i.e.,  $EC_{50} > 1000$  g a.i./ha). At the maximum single seasonal rate of 281.25 g a.i./ha (turf use – ground broadcast application), the screening level risk quotient ( $EEC/EC_{50}/2 = 0.56$ ) does not exceed the PMRA's level of concern (LOC).

Given that the mode of action (nervous system, i.e., disruption of nicotinic acetylcholine receptors of insect nervous system) does not apply to plants, adverse effects to terrestrial vascular plants are not anticipated. Moreover, the collective results of laboratory and outdoor aquatic mesocosm studies demonstrate no adverse effects to phytoplankton or aquatic macrophyte species.

Imidacloprid is registered for pest control on a variety of plant species at a wide range of application rates. Only one Canadian incident has been reported for plants; an individual using a product containing imidacloprid to control grubs on his lawn reported visible injury to the lawn. In the United States, three cases of lawn injury and one case involving the death of 18 rose plants are reported; all of these incidents happened in a residential setting and in all cases the products



were registered for use on the injured plants. Of nine additional incidents reporting damage to various crops, three (tobacco, pecan and lettuce) are listed as the result of registered labelled use. The certainty of these three incidents being related to imidacloprid is classified as possible to probable.

Based on the weight of evidence, imidacloprid is not expected to pose a risk to terrestrial plants.

## **Terrestrial Vertebrates**

### **Foliar applications**

For the bird and mammal risk assessment, the ingestion of food items contaminated by spray droplets is considered to be the main route of exposure. The risk assessment is thus based on the estimated daily exposure which takes into account the expected concentration of imidacloprid on various food items immediately after the last application and the food ingestion rate of different sizes of birds and mammals. At the screening level, only the most conservative exposure estimates are used - i.e., the cumulative application rate for agricultural uses that results in the highest estimated daily exposures (turf use - 281.25 g a.i./ha). The only relevant food item considered for the applications to golf course fairways and sod is short grass and insects since these applications would not result in appreciable exposure to grains and seeds, or fruit.

Screening level risk quotients (RQ) are shown in Table 10. For birds, the level of concern (LOC) is slightly exceeded at the screening level for acute and reproductive effects (RQs range from 1.2 to 2.8). For mammals, the LOC for reproductive effects is slightly exceeded for medium sized mammals feeding on short grass (RQ = 1.4)

To further characterize the risk to birds and mammals, the assessment was expanded to include a range of imidacloprid residue concentrations on all relevant food items at the lowest single and highest cumulative crop application rates (soybean: 24.4 g a.i./ha and raspberry: 112 g a.i./ha  $\times$  3 at 7-day intervals respectively) and the highest foliar application rate for turf use (281.25 g a.i./ha). The risk associated with the consumption of food items contaminated from spray drift off the treated field was assessed taking into consideration the projected spray drift deposition of spray quality of ASAE fine for ground application to soybean and turf (11%) and ASAE fine for airblast application to raspberry (74%) at 1 m downwind from the site of application.

The risk to birds and mammals feeding based on maximum and mean residue values on terrestrial food sources is characterized in Table 11 and Table 12 (Appendix IX), respectively. At the lowest single application rate (soybean), imidacloprid is not expected to pose a risk to birds and mammals.

At the highest cumulative crop application rate (raspberry), the LOC for acute and reproductive effects are exceeded for small and medium sized birds feeding on insects on-field as well as adjacent to treated fields (RQs range from 1.0 - 2.3 for on-field and 0.7 - 1.7 adjacent to treated fields).

The LOC for acute effects is exceeded for large birds feeding on short grass and broadleaf plants on-field based on maximum residue values (RQ = 1.1). The LOC is also exceeded for reproductive effects in medium sized mammals feeding on short grass on-field (RQ = 1.1, based on maximum residue values only).

For turf use, the LOC for acute and reproductive effects are exceeded for small and medium sized birds feeding on-field on insects (RQs range from 1.2 – 2.8). The LOC for acute and reproductive effects is exceeded for large birds feeding on short grass and broadleaf plants on-field (RQ = 1.1 – 1.4) and also for medium sized mammals (RQ = 0.4 – 1.4) based on maximum residue values only.

Although a risk is identified for large birds, and medium and large sized mammals feeding on either shortgrass and/or broadleaf plants, this risk is considered to be low for the following reasons: 1) the level of concern is only slightly exceeded at the highest residues for on-field feeding; no risk is identified for off-field feeding or using the mean residue values, 2) it is unlikely that these food items would comprise 100% of the diet of birds and mammals.

For insectivorous birds, the risk was re-characterized based on residue decline data for imidacloprid in arthropod prey of birds and mammals (Wolf 2004, PMRA 2142783). A  $DT_{50}$  value of 1 day was used to further characterize the risk to birds; the risk to birds feeding on arthropod prey is characterized for the highest cumulative crop application rate on raspberry ( $112.88 \text{ g a.i./ha} \times 3$  at 7-day intervals) in Table 13 (Appendix IX). Based on consideration of the arthropod residue decline data, imidacloprid is not expected to pose a risk to birds at the highest agricultural application rate; although a slight acute risk is identified for small birds at the highest residues (RQ = 1.1), no risk is identified for off-field feeding or using the mean residue values.

Imidacloprid is registered for a single application to turf per season ( $281 \text{ g a.i./ha}$ ), which is approximately three times higher than the highest single agricultural application rate for raspberry ( $112 \text{ g a.i./ha}$ ). Therefore, birds could be exposed to residues in arthropods resulting from turf use that would also exceed the LOC for acute and/or reproductive effects. Although the risk to small and medium sized birds is considered to be relatively low, a label statement is required to inform the user of the potential hazard.

#### **Additional considerations**

The abundance of invertebrates is an important factor in the adequate nutrition of many bird species; the abundance and availability of invertebrate prey during the breeding season is critical to birds in terms of raising offspring and survival. Some research has indicated that indirect effects of imidacloprid (operating through the food chain) may result in reduced survival and/or reproductive success of insectivorous birds. The results of a recent field study conducted in the Netherlands (Hallman *et al.* 2014; PMRA 2576352), shows evidence that suggests that a decline in insectivorous bird populations in farmlands is associated with imidacloprid use via indirect cascade level effects on the food chain. Standardized long term monitoring data (Dutch common breeding bird monitoring and surface water monitoring) was used to determine the extent to

which average surface water concentrations of imidacloprid residues spatially correlate with bird populations. The study demonstrated that local population trends were significantly more negative in areas with higher surface water concentrations of imidacloprid. At imidacloprid water concentrations of more than 20 ng/L, bird populations tended to decline by 3.5 per cent on average annually. Additional analyses revealed that this spatial pattern of decline appeared only after the introduction of imidacloprid to the Netherlands, in the mid-1990s. After correcting for spatial differences in land-use changes that are known to affect bird populations in farmland, the negative relationship was shown to remain. Because these results are correlative, the statistical significance of the negative correlation between imidacloprid concentration in surface waters and insectivorous bird populations of various species does not imply causality as the observed pattern may be explained by other unknown factors (other pesticides, habitat loss, etc.) not considered. However, since neonicotinoids are known to impact non-target invertebrate abundance (as demonstrated in studies examining effects on soil dwelling invertebrates and arthropods and aquatic insects), indirect effects of imidacloprid on insectivorous bird populations (via prey reduction) is a reasonable and valid concern.

### Seed Treatments

When pesticides are used as a seed treatment, the treated seed may be consumed as a food item by both birds and mammals. The risk assessment method for treated seed is similar to that of spray applications, except that the dietary items are treated seeds rather than dietary items sprayed with pesticide. Imidacloprid is registered as a seed treatment for the control of a broad spectrum of insect pests on a variety of cereals, potato, legumes and vegetables. A risk assessment was conducted for birds and mammals to address the intake of treated seed.

The exposure of birds and mammals to a pesticide through consumption of treated seed is a function of the amount of pesticide on the seed, the body weight and food ingestion rate of the animal, and the number of seeds available for consumption. In the screening level assessment, it is assumed that the diet consists entirely of treated seeds, and all of the treated seed that is planted is available for consumption *ad libitum*, over an extended period of time. Variables of feeding preference, availability of treated seed, or potential avoidance behaviour toward treated seed are not considered at the screening level.

The screening level Estimated Daily Exposure (EDE) and risk quotients for each size class of birds and mammals feeding on treated seed are presented in Table 14 and 15 (Appendix IX), respectively; for seed treatments registered with a range of rates the full range of EDEs and RQs are shown. The LOC is exceeded for acute and reproductive effects for all birds and mammals size categories for all seed treatments with the exception barley, wheat and oats for mammals at the lowest seed treatment rate only (100 mg a.i./kg seed). The RQs range from 0.4 (the lowest seed treatment rate for barley, wheat and oats) up to 4405.

It should be noted that for seed belonging to crop group 9A, the risk to birds and mammals was assessed for summer squash, cucumber (pickles), citron melon and pumpkin seed. The risk was not assessed for other crop group 9A seed (muskmelon, watermelon, Chayote (fruit), Chinese wax gourd, cucumber gherkin, edible gourd, *Momordica* spp.) due to a lack of information (i.e.,

seed size, seeding rates). As the rate is the same per seed for all crop group 9A seed crops ( $\sim 2.5 \times 10^{-4}$  g/seed), the risk is expected to be similar across all seeds in crop group 9A.

The screening level risk assessment assumes that all planted seed is available. The risk assessment for birds and mammals was expanded taking into consideration that not all seeds planted will be exposed and available to birds or mammals. The percentage of seeds remaining on the soil surface in field headlands is dependent on the seeding method and the time of year in which seeding occurs (i.e., 0.5% for precision drilling, 3.3% for standard drilling in spring, and 9.2% for standard drilling in autumn). This information was used along with typical seeding rate ranges for each seed crop to estimate the minimum and maximum area required for a bird and mammal to find enough seeds to reach the toxicity endpoint; this refinement does not change the RQ determined.

All crops are assumed to be seeded using standard drilling in spring with the exception of corn which is solely seeded using precision drilling (i.e., planter: vacuum or positive pressure).

### **Birds**

In Table 16 (Appendix IX), the number of seeds needed to be consumed per day to reach the toxicity endpoint is compared to the foraging area required for birds to reach the toxicity endpoint. In some cases, the number of seeds to reach the endpoint is expressed as a range based on known seed size range. Similarly, a range is shown for the area required for foraging based on a range of known seeding rates.

For several seed crops, the number of treated seed needing to be consumed to reach the LOC for avian acute and reproductive intoxication is extremely low, i.e., less than 1 seed for a small bird (for example, sweet corn, field pea, bean seed) and only a few seeds (for example, 1 – 5) for medium sized birds. In some cases, the area required to forage for enough seeds to reach the endpoints is also very small; this is particularly valid for small birds and to a lesser extent for medium sized birds (for example, field pea: 0.1 – 0.8 m<sup>2</sup> for small birds, 1 – 1.9 m<sup>2</sup> for medium sized birds). For large birds, acute and reproductive intoxications are considered less likely with imidacloprid treated seed because of the relatively large number of seeds needing to be ingested and/or the large foraging area required to acquire enough treated seed to reach the endpoints.

For some seed crops (i.e., wheat, spring barley, canola, corn, field pea), a direct comparison of the estimated number of seeds needed to be consumed to reach the acute and reproductive endpoints can be made to the number of seeds eaten by birds observed in the field (as is shown in Table 17 of Appendix IX); the field data originates from field studies that were conducted using untreated seed bait stations to investigate seed preference of bird species (Prosser and Hart, 2005 (PMRA 2574060), Smith 2006 (PMRA 2574059)). The seed preference data from the two field studies covers farmland bird species ranging in weight from 18 to 1317g. To facilitate an objective comparison to the estimated number of seeds needed to be consumed to reach endpoints for the three different bird size categories (20, 100 and 1000g), the seed preference data (i.e., mean and max # seeds consumed per visit) is representative of bird species ranging in weight from 18 to 30g (small sized birds), 80 to 125g (medium birds) and 450 to >1000g (large



birds), respectively. The number of species observed feeding as well as the percentage of seeds dehusked is also shown.

In most cases, the amounts of seed observed consumed during single visits in the field is sufficient to pose a potential risk to birds; i.e., the number of seeds to reach the avian acute and reproductive endpoint is less than or overlaps with the mean and maximum number of seeds observed ingested in the field per visit (Table 17 of Appendix IX). The following exceptions are shown for: medium sized birds feeding on field pea treated at the lowest rate (625 mg a.i./kg seed), large birds feeding on barley and wheat as well as medium sized birds feeding on barley. In Smith, 2006 (PMRA 2574059), few birds were attracted to soybean seed and no species were observed consuming soybean; based on this evidence, treated soybean seed is not anticipated to be a risk to birds.

The number of visits recorded for each bird species for which seed consumption was counted varies greatly depending on seed type and species (for example, 1 Jackdaw visit for wheat and up to 395 visits for robin; Prosser and Hart 2005 (PMRA 2574060)). It should be noted that while only one bird species was observed eating seed in some instances (for example, small bird - house sparrow, mean = 1 field pea consumed per visit), the number of visits which seed consumption was counted was relatively high (86 visits). Due to the potential for repeated visits by a single bird, it is probable that the number of seeds consumed per visit underestimates the amount of seed ingested by birds. For other species, the number of visits by a single species was relative low and the number of seeds eaten was also low (for example, medium sized bird - blackbird observed eating 1 field pea in 1 visit).

The exposure of granivorous birds and mammals to imidacloprid on the treated seed may be reduced by dehusking feeding behaviour; this reduction can be as high as 85 % (Prosser, 2001 (PMRA 2685351)). These authors suggested that dehusking behaviour is a function of the bird's size. Birds with less than 50 grams in body weight generally dehusk small seeds and those with body weights greater than 50 grams are more likely to consume large seeds without dehusking them. The study authors argue that although this behaviour may be the case when birds are not stressed; small birds do not always dehusk seeds due to pressure to feed quickly because of risk of predation, or because of competition for food or space at the feeding site. Furthermore, reduction in exposure to imidacloprid from dehusking will depend on the kind of seed and whether the seed is fully or partially dehusked. Based on field observations of birds feeding from untreated seed bait stations, birds less than 50 g in body weight did not consistently dehusk seeds (for example, wheat, barley and rapeseed); observed dehusking behaviour ranged from not at all for some bird species to 20 - 100% for others depending on seed type (from Prosser and Hart, 2005 (PMRA 2574060)).

The seed consumption data from the field studies represents a worst case scenario for a single feeding bout because of the high seed availability at the baiting stations. More typical seed densities such as those left on the soil surface after seeding would be expected to attract fewer birds. Feeding rates would also be lower on seeded fields than at feeding stations as birds would take more time to find and move between seeds.

However, in several instances, the area required to forage for enough seeds to reach the endpoints is shown to be very small (a few m<sup>2</sup> or less as shown in Table 16 of Appendix IX); for such cases, the use of the seed consumption data observed at bait stations can be considered a realistic and suitable comparison to the number of seeds required to reach the avian endpoints.

### **Mammals**

The number of seeds needed to be consumed per day to reach the toxicity endpoint and the foraging area required for mammals to reach the toxicity endpoint is shown in Table 18 (Appendix IX).

Acute and reproductive intoxications are not likely with imidacloprid treated seed for some small mammals because of the large number of seeds needing to be ingested and/or the large foraging area required to acquire enough treated seed to reach the endpoints (i.e., 1000g sized mammals). For a few seed crops, however, the number of treated seed needing to be consumed to reach the LOC for acute and reproductive intoxication is particularly low and, therefore, raises a potential risk concern - i.e., approximately one seed for a small mammal (for example, field pea, bean seed) and only a few seeds (for example, 1 – 5) for medium sized mammals. The area required to forage for enough seeds to reach the endpoints is also small, particularly for small mammals (for example, field pea: 0.4 – 1.1 m<sup>2</sup> for small mammals, 0.8 – 2.5 m<sup>2</sup> for medium sized mammals). Imidacloprid treated seed may pose a risk to mammals for all seed treatments with the exception of wheat, barley and oats; a risk to mammals is not anticipated for these treated seeds due to the relatively large number of seeds that would need to be ingested to elicit acute and reproductive intoxication as well as the large foraging area that would be required to find enough treated seed to achieve toxicity.

For granivorous mammals, several studies have demonstrated that dehushing occurs under laboratory as well as under semi-field conditions but do not provide quantitative information on the effect of dehushing (for example, Barber *et al.* 2003). The efficiency of dehushing by laboratory mice and wild *Apodemus* mice is strongly dependent on seed structure (Ludwigs *et al.* 2007 - for example, dehushing of sunflower seeds where the seed coat and the fruit coat are not grown together was highly effective (c. 90%) whereas dehushing of corn seeds was less effective, 62-65%). It must be assumed, however, that under field conditions some of the stressors mentioned for birds will also apply to mammals, reducing the efficiency of dehushing. Assuming a standard reduction (for example, 85%, or any other value) of the theoretical exposure in bird or mammal species that dehush is, therefore, not justified. Given that in some cases the risk assessment shows that less than 1 seed needs to be ingested to exceed the LOC, even if part of the seed coating is lost at seeding or some imidacloprid is discarded when the seeds are hulled the critical dosing may be exceeded for acute and reproductive effects.

### **Synthesis**

Based on the collective results of the risk assessment, (i.e., low number of seeds and small foraging area required to find enough treated seed to reach the acute and reproductive LOC), imidacloprid seed treatments may pose a potential risk to birds with the exception of soybean as

there is field evidence that supports that birds are not attracted to soybean seed. Information on potential attractiveness of some seed types is lacking. Imidacloprid seed treatments may pose a potential risk to small wild mammals with the exception of wheat, barley and oats. Risk mitigation measures include requirements to incorporate or remove any spilled or exposed treated seed from the soil surface to help reduce exposure.

### **Additional considerations**

#### ***Potential for exposure to treated seed***

The risks found are only applicable for the few days after planting treated seed before transformation of imidacloprid occurs and before the seed germinates. Significant exposure, however, may occur at field edges where turning and lifting of planting equipment will lead to treated seed being left on the soil surface. These locations on the field will provide birds and small mammals with some semblance of cover from predation and, potentially, greater exposure to treated seed. Exposure can occur also midfield by means of erratic application from dispensing units resulting from incorrect calibration, clogging or obstructions such as stones. Furthermore, the risk to birds (and small mammals) was assessed on the basis of the amount of treated seed on the soil surface and ignores the fact that birds can dig up treated seeds that are buried. Avian probing behaviour for seeds buried beneath soil is reported for a number of species (for example, geese, Western meadowlark, blackbirds and skylarks; Mineau and Palmer 2013 (PMRA 2544546)). According to De Leeuw *et al.*, 1995, "It is not only the treated seeds on the soil surface that are available to birds and small mammals: buried seeds may also be eaten. Mice and birds can dig out sugar-beet seeds. Birds can ingest treated seeds by pulling out seedlings. There is therefore no certainty that a field with only a small number of seeds on the soil surface does pose a low risk to birds or small mammals."

The potential for exposure to birds and small wild mammals associated with feeding on treated seed left on the soil surface can be reduced by informing users of the potential toxicity hazard to birds and mammals and providing instructions that spilled and exposed seeds must be incorporated into soil or cleaned-up from the soil surface. While exposure would be reduced, there may still be risk to birds because of the low number of seeds needed to be ingested to elicit toxicity (for example, in some cases, as little as 1 to 5 seeds). However, there is uncertainty whether or not treated seeds would be an attractive food source for birds and mammals.

It should be noted that broadcast seeding for canola is used when field conditions are poor due to inclement weather and/or fields too wet for seeding (Canola Council of Canada<sup>17</sup>); exposure to birds and mammals in this case would be to an unlimited number of treated canola seeds dispersed directly on top of the soil surface.

<sup>17</sup>

Canola Council of Canada - <http://www.canolacouncil.org/>

Additional information can be found at Canola Watch which is funded by the Canola Council of Canada - <http://www.canolawatch.org/2015/05/13/broadcast-seeding-canola-tips/>

### ***Other risk assessments***

Additional risk assessments for birds foraging on imidacloprid treated seed are available (Mineau and Palmer 2013 (PMRA 2544546), Smith 2006 (PMRA 2574059)). Although there are differences in the risk assessment methods used and the acute and chronic endpoint values chosen, the results of these assessments corroborate the results of the current risk assessment.

Mineau and Palmer (2013) followed a deterministic approach to evaluate the risk to birds feeding on neonicotinoid treated seed. Similar risk assessment methods were used as in the current assessment (for example, acute  $HD_5$  determination, allometric food ingestion equations from Nagy, 1987) with slight variations (for example, the acute SSD incorporated body weight scaling, an approach ensuring that species at one or the other end of the weight range spanning 10 to 1000g are adequately covered). The risk assessment differs in that imidacloprid seed treatment rates for wheat, corn and canola were considered based on the registered United States use pattern (0.033, 1.34 and 0.03 mg a.i./seed, respectively; these rates are approximately double those registered in Canada (0.013, 0.63 and 0.015 mg a.i./seed, respectively). The estimated number of seeds needing to be ingested by a 15g bird to exceed the acute  $HD_5$  was 3.9, 0.1 and 4.4 seeds, respectively. For chronic reproductive effects, the estimated number of seeds needing to be ingested was lower (1.3, 1.5 and 0.03 mg a.i./seed, respectively). Both estimates for acute and chronic intoxication are similar to those determined in the current assessment.

Smith (2006) conducted an avian risk assessment for 17 different actives used as seed treatments in Canada. The assessment considered actual avian seed ingestion data from field observations for five seed crops (corn, oat, wheat, barley and soybean); risk to birds was determined for imidacloprid treated corn seed only as the other seed types were not registered as seed treatments at the time. The assessment considered the maximum seed treatment rate (equivalent to 0.67 mg a.i./seed) and the observed values for the maximum seed intakes (meal sizes) from the field. The deterministic risk assessment showed that all species observed feeding on corn (red-winged blackbird, mourning dove, mallard and blue jay) were at acute and chronic risk from ingesting imidacloprid treated corn seed. A probabilistic risk assessment was also conducted to better quantify the acute hazard posed to birds. In addition to maximum feeding bouts (used in the deterministic assessment), the probabilistic risk assessment model used the full range of meal sizes from the field data (for blue jay and red-winged blackbird) as well as distributions of other variables. Treatment of corn with imidacloprid at the maximum application rate was shown to present a high risk to these two bird species: the probabilistic assessment estimated that treatment of corn with imidacloprid at the maximum application rate presents a high risk to bluejays and redwing black birds feeding on treated seed as 24% of blue jays and 29% of red-winged blackbirds would be expected to die 50% of the time. Expressed as a regional impact, 24% of blue jays and 29% of red-winged blackbirds would be killed on 50% of fields having imidacloprid treated corn seed. Similarly, the probability of mortality for blue jays and red-winged blackbirds is 91% and 99%, respectively, 10% of the time; that is 10% of all "treated" fields would have close to 100% mortality of birds.

In European countries, the use of some imidacloprid seed treatments has been suspended. In EFSA's 2008 re-evaluation of imidacloprid, treated pelleted sugar beet seed was considered for the bird and mammal risk assessment (imidacloprid is not registered for sugar beet seed



treatment in Canada). The consideration of sugar beet seed in EFSA's assessment is unclear as imidacloprid is used as a seed treatment in some countries for other crops (for example, France – cereals); it is assumed that sugar beet represents the highest seed treatment rate and exposure scenario for birds and mammals. EFSA concluded that the risk to birds is low for the uptake of pelleted seeds but a potential high acute risk could not be excluded for granivorous mammals. A potential high acute risk to herbivorous birds was determined for the consumption of sugar beet seedlings.

#### ***Preference, avoidance and repellency***

Under laboratory conditions, red-winged blackbirds and brown headed cowbirds have demonstrated avoidance of imidacloprid treated rice and wheat seed at rates as low as 620 and 165 mg a.i./kg seed, respectively (Avery 1993, 1994 (PMRA 2574061)). Avoidance was shown to be a learned response mediated by post-ingestional stress rather than a sensory repellent or irritant. These tests employed a two-cup design that makes it easy for birds to recognize and avoid treated seed when untreated seed is fed alongside. In addition, exposure to the treated seed was brief and the birds received their normal ration before and immediately after exposure to the treated seed and untreated alternative. The birds were, therefore, not subjected to any form of food stress. The authors argued that while avoidance due to post-ingestional illness may be easy for birds to relate to contaminated feed under laboratory conditions, it may be more difficult for wild birds when habitual food sources become contaminated and birds are suffering hunger stress.

Smith (2006) investigated the potential use of avian seed colour preference towards strategies to reduce bird exposure to pesticide treated seed; studies were conducted under both laboratory and field conditions with a particular emphasis between UV absorption and reflection forms of colour (red, green and blue). In laboratory trials, a significant difference in preference was shown for zebra finches consuming UV reflecting seed (browntop millet): red > green > blue. In the absence of UV reflection, however, birds showed no preference between blue and green seed but the preference for red seed remained. An initial avoidance was observed for birds feeding on UV reflecting blue seed, but this was short lived; in the absence of negative consequence (for example, bad taste) birds became increasingly less selective. A definitive preference was also observed for red seed (black-oil sunflower seed) under field conditions for some birds (i.e., black-capped chickadees and blue jays) while other species showed no preference. The consistent preference for red seed demonstrated in the lab and field raises a particular concern as red is a colour used to signify pesticide treated seed for a variety of seed types (i.e., Canadian colour standard for cereals<sup>18</sup> – for example, wheat, oats, barley, corn).

#### ***Incident reports***

No incidents of bird or mammalian poisoning have been reported in Canada or the United States related to imidacloprid treated seed. Mortality incidents for birds with imidacloprid treated seed, however, have been documented in France (Berny *et al.* 1999 (PMRA 2574056); Bro *et al.* 2010 (PMRA 2574057)). In Berny *et al.* 1999, birds were reported to appear weak and reluctant to

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<sup>18</sup> Canadian Grain Commission - <https://www.grainscanada.gc.ca/oggg-gocg/ggg-gcg-eng.htm>; PMRA Regulatory Directive DIR94-06: [http://www.hc-sc.gc.ca/cps-spc/alt\\_formats/pacrb-dgapcr/pdf/pubs/pest/pol-guide/dir/dir9406-eng.pdf](http://www.hc-sc.gc.ca/cps-spc/alt_formats/pacrb-dgapcr/pdf/pubs/pest/pol-guide/dir/dir9406-eng.pdf)

move and unable to fly; dead birds all contained coated seeds in their digestive system and tested positive for imidacloprid residues (n = 12 partridges, n= 7 pigeons). In Bro *et al.* 2010, toxicological analysis carried out on grey partridge, which can nest in cereal residues in France, report several imidacloprid associated bird poisonings from 2003 to 2007 (a summary of incidents is shown in Table 2). Grey partridge were collected as part of a national surveillance program in France (SAGIR); all birds were collected in October only (mainly by hunters), coinciding with winter crop sowing (for example, winter wheat) and hunting season. Avian mortality incidents related to imidacloprid have been reported by the SAGIR network as early as 1995 (i.e., death of grey partridges associated with imidacloprid treated winter barley seed – reported in Proceedings of Wildlife Health Center Conference 1999). According to Smith (2006), bird intoxications in France from imidacloprid treated seed are reported routinely (cited as Terrier *et al.* 2002/2003 and 2004; no other details were provided). Although the conditions of mortality are unknown (for example, seed concentration), these incidents suggest that avoidance/repellency of imidacloprid treated seed is not relevant under field conditions. Therefore, there is a risk of concern to birds from feeding on seeds treated with imidacloprid.

**Table 2 Grey Partridge Death as Related to Imidacloprid Seed Treatments Reported Under National Surveillance Network in France (SAGIR) from 2003 to 2007; (All Birds Were Collected in the Month of October Which Coincides With Hunting Season).**

| Year | Number of dead birds collected | Number of birds analyzed | Number deaths associated with imidacloprid poisoning |
|------|--------------------------------|--------------------------|------------------------------------------------------|
| 2003 | 12                             | 12                       | 12                                                   |
| 2004 | 3                              | 3                        | 3                                                    |
| 2005 | 4                              | 3                        | 3                                                    |
| 2007 | 9                              | 8                        | 8                                                    |

Although there are no reported avian incidents in North America, the occurrence of such incidents cannot be ruled out for the following reasons:

Incidents of avian mortality are more easily observed and reported for large birds because they are more visible and tend to flock in large numbers on-field (for example, geese and waterfowl – diazinon and carbofuran). The assessment identifies potential risk to small birds and to a lesser extent medium sized birds; a lack of avian mortality incidents related to imidacloprid treated seed, therefore, is not unexpected as small dead birds are less conspicuous and typically do not forage together in noticeably large numbers relative to large bird species.

Dead birds can be quickly scavenged from the site; the window of opportunity for observing dead birds on fields, therefore, may be short. Poisoned birds may move from the site to die elsewhere.

## Granular Applications

Imidacloprid is registered in granular form for use on turf to control various turfgrass insect larvae (for example, white grubs). Birds and mammals may be exposed to imidacloprid in its granular form through inadvertent ingestion of granules (i.e., granules adhered to selected food or picked up with other extraneous material during feeding); ingestion of prey containing pesticide residues (secondary poisoning); and mistaking granules for food. Mammals are only likely to consume granules unintentionally, therefore, the actual number of granules that would be consumed is expected to be very low (i.e., mammals will not actively search out inorganic granules for consumption). Unlike mammals, birds may actively search out granules for use as grit, and therefore exposure may be relatively high.

The risk assessment presented is for granular commercial products (Tables 19 to 21 of Appendix IX).

The exposure of birds and mammals to a pesticide through consumption of granules is a function of the amount of pesticide contained within the granule, the body weight and food ingestion rate of the animal, and the number of granules available for consumption. For the screening level assessment, it is assumed that the bird and mammal diets will consist entirely of treated granules and that the granules are available *ad libitum*, over an extended time period.

The risk was assessed using the same generic bird and mammal body weights and toxicity endpoints selected for use in the foliar application and seed treatment risk assessments. These endpoints were converted to the number of granules needed to be consumed per day to reach the toxicity endpoint for each of the small, medium and large size classes of birds and mammals (shown in Table 19 of Appendix IX). The number of granules consumed per day calculated for each bird and mammal body weight category is presented in Appendix IX: Table 20. To assess the risk to birds and mammals from consumption of treated granules a risk quotient is calculated as:

# of granules consumed per day (Table 20) ÷ # of granules to reach the endpoint (Table 19)

The calculated risk quotients are listed in Table 21 (Appendix IX). Risks were found for all birds and mammals.

The calculation of the risk quotients assumes a highly conservative worst case scenario (i.e., 100% of the granules consumed by birds and mammals are treated granules). For birds, a more realistic exposure estimate can be used by considering the number of grit particles consumed in different bird species as well as the preferred size distribution of grit particles for different bird species. Luttik and deSnoo, 2004<sup>19</sup> examined the number and size distribution of particles found in 27 species of birds.

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<sup>19</sup> Luttik, R. and G.R. de Snoo (2004). Characterization of grit in arable birds to improve pesticide risk assessment. *Ecotoxicology and Environmental Safety* 57: 319-329.

Based on results from Luttik and deSnoo (2004), the number of grit particles >0.75 mm in size consumed by many species of birds exceeds the number of granules required to reach avian acute or reproductive toxicity endpoints. Therefore, exposure to imidacloprid from the ingestion of granules may pose a risk to birds.

Small mammals are only likely to consume a granule unintentionally, therefore, the actual number of granules that would be consumed is expected to be very low (i.e., small mammals will not actively search out inorganic granules for consumption). The exposure value for mammals may then be further characterized as a low percentage of the EDE based on consumption as food (i.e., 1 - 5% of the EDE based on consumption as food). Risk quotients for mammals based on an estimate of incidental consumption as 1% of the EDE are shown in Table 22 (Appendix IX). For small mammals eating only 1% of the estimated daily exposure for granule ingestion, the risk quotients do not exceed the LOC for any effects. Exposure to imidacloprid from inadvertent ingestion of granules is not expected to pose a risk to mammals.

#### **Additional considerations**

Although no Canadian incident reports have been reported involving birds and mammals for the use of imidacloprid turf products, incidents are reported based on residential use of imidacloprid on turf in the United States. Based on an incident in Pennsylvania (1998), a total of 7 birds appear to have been poisoned after feeding on grubs after treatment. In New Jersey (June, 2001), four Canada geese were found dead or dying on a golf course; a mixture of chlorpyrifos and imidacloprid had been used on the course but the lack of cholinesterase inhibition suggested imidacloprid may have been responsible. On a South Carolina residential property treated with imidacloprid in 2002, 6 mallards were found dead or dying but no other information was provided. It is unclear whether these turf use related incidents involved liquid or granular formulations of imidacloprid. These incidents also appear to be based on acute exposure events. It could be suggested that the reported incidents related to imidacloprid may only represent a small portion of the actual mortality caused by exposure because intoxicated birds could move away from the site to die thus, never being detected. Other issues that could result in a reduced number of incidents reported are scavengers quickly removing carcasses from the site and individuals may not know how to report kills that are discovered. It should be noted that chronic problems affecting wildlife from the use of imidacloprid would be expected to largely go unnoticed in the field.

Since the granular imidacloprid products are to be watered after application, the potential exposure period for which birds would have an opportunity to ingest a harmful amount of granules may be of short duration; exposure of birds to imidacloprid in concentrations sufficient to cause effects, therefore, is expected to be minimal. To further reduce the potential risk, it is recommended that the current label direction on commercial granular product labels requiring irrigation or rainfall within 24 hours after application of granules, be reduced to a watering period within 12 hours after application:

***The granules must be watered within 12 hours after application by sufficient irrigation (5-10 mm) to ensure the active moves through the thatch.***



This differs from the domestic turf product label (residential use; PCP 29738) which stipulates that watering must occur within 1 hour after application of granules. However, for larger areas of turf coverage analogous to commercial settings, a longer period of time between application and watering would be required to remain logistically feasible.

#### **4.2.2 Risks to Aquatic Organisms**

A summary of aquatic toxicity data for imidacloprid is presented in Tables 23 to 28 (Appendix IX). Toxicity information for the transformation products of imidacloprid is limited and available for freshwater invertebrates only. Freshwater invertebrates are shown to be far less sensitive to transformation products (for example, imidacloprid-urea, imidacloprid-guanidine) than to parent imidacloprid. As invertebrates demonstrate the greatest sensitivity to imidacloprid, the risk assessment is based solely on toxicity and exposure to imidacloprid.

#### **Screening Level Assessment**

For the initial conservative screening level assessment, the highest application rates were chosen from among all use types and crops. The initial conservative screening level assessment considered the highest maximum annual application rate registered for use on crop group 9 – cucurbit vegetables (586.9 g a.i./ha) based on direct application to water bodies with a depth of 15 cm (seasonal water body for amphibian endpoints) and 80 cm (permanent water body for remaining endpoints).

For the assessment of risk, toxicity endpoints chosen from the most sensitive species tested were used as surrogates for the wide range of species that can be potentially exposed following treatment with imidacloprid. The acute endpoints were derived by dividing the  $EC_{50}$  or  $LC_{50}$  from the appropriate laboratory study by a factor of two (2) for algae and aquatic plants, and by a factor of 10 for fish and amphibians to account for potential differences in species sensitivity as well as varying protection goals (i.e., protection at the community, population, or individual level).

Risk quotients for aquatic organisms other than invertebrates were below the level of concern ( $RQ < 1$ ), consequently, imidacloprid is not expected to pose a risk to fish, amphibians, algae and aquatic plants.

#### **Refined Risk Assessment**

Sufficient toxicity data were available for freshwater invertebrates and estuarine marine invertebrates to determine  $HC_5$  values (the 5<sup>th</sup> percentile of the species sensitivity distribution (SSD) for the  $LC_{50}$  at 50% confidence intervals). Based on available acute and chronic toxicity endpoints for 32 and 10 freshwater invertebrate species, respectively, acute and chronic  $HC_5$  values of 0.36 and 0.041  $\mu\text{g/L}$  were determined, respectively. For marine invertebrates, an acute  $HC_5$  value of 1.37  $\mu\text{g/L}$  was determined based on six marine species. There were not enough data available to determine a chronic  $HC_5$  value for marine invertebrates.

Details regarding the HC<sub>5</sub> estimations are provided in Appendix XI. The freshwater invertebrate acute value (0.36 µg/L) and chronic HC<sub>5</sub> value (0.041 µg/L) are consistent with several other published reviews (EFSA 2014, Vijver and van den Brink 2014 and Morrissey *et al.* 2015).

The screening level risk assessment for aquatic organisms is presented in Table 29 (Appendix IX). Toxicity endpoints for freshwater and estuarine marine invertebrates were one to three orders of magnitude lower than the screening level EECs; the risk quotients greatly exceed the level of concern (RQ = 54 -1790) for acute and chronic effects for aquatic invertebrates.

### **Aquatic field studies**

Higher tier studies confirm that the most sensitive aquatic organisms are invertebrates. Studies of ecological effects of imidacloprid investigated under a variety of microcosm/mesocosm conditions simulating lentic and lotic environments consistently show that certain components of the invertebrate community are particularly at risk; (brief summaries of study results are shown in Table 27 of Appendix IX).

Lentic pond systems consistently showed that exposure to imidacloprid decreased species diversity and abundance of the invertebrate community; effects occurred at environmentally relevant concentrations. Insect taxa were particularly sensitive to imidacloprid exposure (larvae and emerged adult species – for example, Chironomidae, Ephemeroptera, Trichoptera, Diptera) than other invertebrate taxa (zooplankton – for example, cladocerans, copepods). In some cases, species were negatively affected immediately after a single imidacloprid pulse (for example, caddisfly larvae – *Neurichthys* sp.) while others (for example, Ephemeroptera, Diptera) were affected only after repeated imidacloprid pulses, sometimes at low concentrations; the study results suggest that a pulse exposure of imidacloprid may have a long-term influence on the recovery of some aquatic and benthic organisms, despite low residual concentrations in water. In studies that were of sufficient duration, macrozoobenthos and zooplankton communities were shown to recover within six to eight weeks after the last application.

Phytoplankton and periphyton communities showed no direct effects from imidacloprid exposure; in some cases transient effects (increase or decrease in abundance) were observed, however, these effects were not considered to be treatment related. Effects on aquatic macrophytes were examined in only one study; no apparent treatment related effects on macrophyte biomass were evident, however, macrophyte standing crop was only assessed 12 weeks after the last application.

Statistically significant reductions in body size of juvenile and adult medaka fish were observed in experimental rice paddy mesocosms; these observations may have been indirectly related to imidacloprid effects on medaka food sources (zooplankton abundance). No other adverse effects (i.e., parasite infestation, malformations, reduced swimming capacity) were found. In a similar study, however, no significant reduction in body size or morphological abnormalities were observed in medaka, but exposure to imidacloprid did result in significantly increased physiological stress as a result of increased parasitic infestation.

Although some fish mortality (5%) was also observed in the first 4 days of exposure, further losses of fish in subsequent weeks could not be attributed to acute toxicity due to the possible influence of predation (i.e., black-crowned herons visiting the experimental fields at night was reported).

In artificial stream mesocosms (representative of lotic systems), imidacloprid pulses reduced benthic invertebrate abundance and community diversity (for example, Ephemeroptera, Plecoptera, Tricoptera, oligochaetes). Indoor lotic stream simulations demonstrate that imidacloprid concentrations as low as 1.0 µg/L (nominal) can initiate macroinvertebrate drift behaviour (for example, amphipods – *Gammarus pulex* and *roeseli*, mayfly larvae – *Baetis rhodani* and *fuscatus*); the relevance of this data, however, is uncertain as the frequency and duration of invertebrate exposure to imidacloprid is likely to vary considerably within natural lotic environments depending on several factors (for example, distance, flow rate, light regime and turbidity).

Significant reductions in size of some species tested (*Baetis* and *Epeorus* spp.) were found at concentrations <0.1 µg/L. The implications of impaired development and growth on reproductive success in mayflies should not be discounted. Reduced reproductive success has the potential to impact streams that depend on insect processes to maintain function (for example, nutrient cycling, primary productivity, decomposition, and translocation of materials).

Despite consistent results among individual mesocosm studies, demonstrating negative effects to aquatic invertebrates, a collective interpretation of the data is difficult and problematic due to a number of deficiencies that include:

- 1) An inadequate number of exposure concentrations;
- 2) Population/community level effects were not measured;
- 3) An application regime that is not representative of the most conservative exposure scenario;
- 4) An inadequate study duration to measure recovery;
- 5) An exposure scenario that is not applicable to the Canadian use pattern (for example, rice seedling treatment followed by transplant to mesocosms); and
- 6) Low abundance of sensitive invertebrate species, i.e., Ephemeroptera, prevented reliable statistical evaluation (low power) of effect and recovery.

A NOEC to cover the most sensitive invertebrate population observed in the aquatic field studies could not be derived due to the lack of information on more sensitive species such as Ephemeroptera (i.e., effects were observed at the lowest treatment concentration or low abundance prevented a reliable statistical evaluation of a NOEC and recovery).

In the absence of a suitable mesocosm NOEC, an SSD approach was used to determine acute and chronic HC<sub>5</sub> values (based on laboratory data) for the aquatic invertebrate risk assessment; this approach was used by EFSA in their 2014 risk assessment for aquatic organisms based on similar conclusions regarding available mesocosm data.

## Assessment of Potential Risk from Spray Drift

The risk to aquatic invertebrates was further characterized by taking into consideration the concentrations of imidacloprid that could be deposited through spray drift in off-field aquatic habitats that are downwind and directly adjacent to the treated field. End-use products containing imidacloprid are applied by a variety of foliar spray application methods (including field sprayer, airblast and aerial applications) that may result in spray drift. The maximum amount of spray that is expected to drift 1m downwind from the application site during spraying using field sprayer and aerial application methods is determined based on a fine spray droplet size: field sprayer – 11%, aerial – 26%. The maximum amount of spray that is expected to drift 1m downwind from the application site during spraying using airblast application is 74% and 59% for early and late applications, respectively. Given the variation in percent drift off site for each of the application methods, the assessment of potential risk from drift was assessed for the minimum single ground application for soybean (24.4 g a.i./ha) and the maximum cumulative airblast application rate for raspberry (112 g a.i./ha  $\times$  3 applications at 7-day intervals); these application rates cover the full range of foliar spray rates and application methods. The aquatic EEC for the highest cumulative application rate has been revised by adjusting the sum of the applications for dissipation between applications using the 80<sup>th</sup> percentile of aerobic aquatic whole-system representative half-lives ( $T_R$ ), 191 days (i.e., determined from four  $T_R$  values adjusted to 25°C).

The risk to aquatic invertebrates resulting from spray drift is summarized in Table 30 (Appendix IX). The risk quotients indicate that the LOC is exceeded for freshwater and marine invertebrates exposed to drift from all applications and methods on an acute basis with the exception of freshwater and marine invertebrates at the lowest field sprayer single application rate (RQs range from 0.2 to 83). On a chronic basis, the RQs indicate that the LOC is exceeded for all aquatic invertebrates and all application methods (RQ = 1.0 – 732). Mitigation in the form of buffer zones is required.

## Runoff Refinement

Aquatic organisms can also be exposed to imidacloprid as a result of runoff into a body of water. The Surface Water Concentration Calculator (SWCC) model was used to predict estimated environmental concentrations (EECs) resulting from runoff of imidacloprid following application. The models were run at the lowest single foliar or soil application rate (to assess risk at the lowest possible use rate) and the highest rate (to cap the highest risk possible): the lowest and highest seasonal application rate is for use on crop group 9 (curcurbit vegetables) at 20.5 and 586.9 g a.i./ha, respectively; the application method used in the modelling was ground application via transplant water and the rate is based on the maximum field planting rate for pickling cucumbers. The Level 1 imidacloprid EECs in a 1-ha receiving water body (80 and 15 cm deep) predicted by SWCC for these crops applications are presented in Table 31 and 32 of Appendix IX, respectively. The values reported by SWCC are 90<sup>th</sup> percentile concentrations of the concentrations determined at a number of time-frames including the yearly peak, 96-hr, 21-d, 60-d, 90-d and yearly average. The EECs used for calculation of the RQs were the highest values at the appropriate depth and appropriate time-frame.



Acute and chronic RQ values were calculated using an EEC for the time frame which most closely matched the exposure time used to generate the endpoint (for example, a 96 hour LC<sub>50</sub> would use the 96 hour value generated by the model; a 21 day NOEC would use the 21 day EEC value). The acute and chronic endpoints for invertebrates are based on data with 48 hour and approximately 21 day exposure periods, respectively. The acute and chronic RQ values for freshwater organisms are reported in Table 33 (Appendix IX). The RQs derived for acute and chronic exposure exceed the LOC in freshwater and marine invertebrates at all imidacloprid application rates (freshwater RQ = 1.3 – 607).

No incidents involving freshwater invertebrates have been reported in Canada related to imidacloprid use. In the United States, an incident involving the death of approximately 3000 crayfish is reported as a result of registered use of imidacloprid. Crayfish mortality was observed along a half mile stretch of creek one day after application of a granular imidacloprid product to turf; the treated lawn was approximately 5000 feet from the creek and a storm drain leading to the creek was located in the vicinity (within 1000 feet of the creek). Precipitation was reported on the day of application as well as the day of the incident; runoff is considered the primary route of exposure. Three water samples were collected and imidacloprid was measured at concentrations of 0.049 - 0.056 ppb. The certainty of the incident being related to imidacloprid is classified as probable.

### **Water Monitoring**

There were sufficient imidacloprid surface water monitoring data available for freshwater to consider in the risk assessment. The data were representative of several different use patterns. A summary of monitoring data for imidacloprid and its transformation products in surface water bodies relevant to the aquatic risk assessment is presented in Appendix X.

Approximately 11,350 freshwater samples were available for imidacloprid in Canada and the United States. In contrast, few monitoring data for imidacloprid in estuarine or ocean water from Canada or the United States were available (21 samples).

The risk assessment for aquatic organisms was refined by considering available Canadian and American monitoring data. As an initial step, appropriate acute and chronic freshwater EECs were chosen based on the monitoring information.

An acute freshwater EEC of 11.9 µg/L (the maximum concentration of imidacloprid detected in Canadian surface freshwater) and a chronic freshwater EEC of 1.26 µg/L (the highest average concentration estimated from several individual imidacloprid monitoring data sets for Canadian freshwater bodies) were used for the risk assessment. Although imidacloprid was detected at a maximum concentration of 25 µg/L in a pond water sample from a golf course in a rural area of Maryland, United States, this value was not selected because it may not be representative of the Canadian use pattern. For marine/estuarine invertebrates, the data set was not robust; no Canadian data were available, and minimal American data were available. Due to the paucity of data, an EEC based on monitoring data was not used to assess risks for marine/estuarine invertebrates.

The freshwater invertebrate endpoints for acute and chronic exposure are 0.36 µg/L (the HC<sub>5</sub> of LC<sub>50</sub> values) and 0.041 µg/L (the HC<sub>5</sub> of chronic EC<sub>50</sub>s), respectively. The RQ values calculated using the highest selected values from the monitoring data (Table 34 of Appendix IX), indicate that the LOC for acute and chronic effects is exceeded for freshwater invertebrates (RQ = 33 and 31, respectively).

A more detailed analysis was conducted for freshwater invertebrates by further considering the available Canadian monitoring data sets. Additional information regarding the specific sampling locations and associated uses was considered as data sets allowed. Details of this expanded risk assessment for freshwater invertebrates using monitoring data can be found in Appendix X. A summary of the major findings follows.

Robust Canadian freshwater monitoring data were available for areas of Ontario, Quebec and Saskatchewan. Monitoring data were typically scarce or not robust for other areas of Canada. However, in areas where imidacloprid is used but monitoring data are lacking, there is no reason to believe that detection patterns would differ compared to those observed in areas where monitoring data are available.

Aquatic endpoints were exceeded very frequently at some sites. For instance, at two sites, imidacloprid concentrations exceeded the chronic endpoint 100% of the time. Levels exceeded the acute endpoint 71% of the time at one site.

Based on the robust Canadian data sets, higher concentrations and more frequent exceedances of acute and/or chronic endpoints for freshwater aquatic invertebrates were associated with:

- greenhouse uses in Ontario
- vegetables uses in Ontario (seed treatment, foliar spray and/or soil applications)
- potato and mixed vegetable/potato uses in Quebec (seed treatment, foliar spray and/or soil applications)

Despite these associations, the risks to aquatic invertebrates cannot be readily attributed to an application method (for example, seed treatment, foliar uses or soil applications). This is because all application methods may be used on crops in areas where imidacloprid is detected (vegetables and potato uses).

Monitoring data likely provide an underestimate of actual exposure, as sampling typically does not capture peak concentrations.

The intensity of use in the watershed affects levels of imidacloprid in water; higher intensity of use (based on percentage of a crop in the watershed) typically results in higher levels in water.

The use areas/crops surrounding waterbodies sampled differ between data sets.

The multiple uses within some watersheds complicate the task of relating imidacloprid levels in water to a specific use.

### **Synthesis**

In conducting environmental risk assessments, it is the PMRA's policy to always consider both monitoring data (when available) and EECs generated using water models as part of its overall risk assessment. Although valid monitoring data are considered preferable to modelled EECs, the weight given to these data varies depending on the circumstances. The risk assessment based on the modelling results indicates that imidacloprid may pose an acute and chronic risk to both freshwater and marine invertebrates. Typically modelling inputs and assumptions are conservative and the EECs generated are considered to be higher than actual concentrations present in representative water bodies. For imidacloprid, however, the range of surface water EECs predicted from modelling (based on lowest to highest foliar or soil agricultural application rate) overlaps with the range of concentrations measured in surface waterbodies. Imidacloprid may pose an acute and chronic risk to marine/estuarine invertebrates based on water modelling results. The monitoring data for imidacloprid in marine/estuarine environments are not robust enough to exclude risks to marine/estuarine invertebrates.

Risks to freshwater invertebrates were identified based on monitoring data, and have been further evaluated using robust Canadian data sets. For imidacloprid, higher concentrations and more frequent exceedances of acute and/or chronic endpoints for freshwater aquatic invertebrates were associated with:

- greenhouse uses in Ontario
- vegetables uses in Ontario (seed treatment, foliar spray and/or soil applications)
- potato and mixed vegetable/potato uses in Quebec (seed treatment, foliar spray and/or soil applications)

Despite these associations, the risks to aquatic invertebrates cannot be readily attributed to an application method (for example, seed treatment, foliar uses or soil applications). This is because all application methods may be used on crops in areas where imidacloprid is detected (vegetables and potato uses).

#### **4.2.3 Incident Reports**

Since 26 April 2007, registrants have been required by law to report pesticide incidents to the PMRA that are related to their products. In addition, the general public, medical community, government and non-governmental organizations are able to report pesticide incidents directly to the PMRA. Two environmental incidents relating to the active ingredient imidacloprid were found in the PMRA database. Lawn damage was reported in one incident; and in another incident a fish kill occurred following a fire at a chemical warehouse where imidacloprid was one of many pesticides stored. In the fish kill incident, it could not be confirmed whether or not imidacloprid contributed to the fish mortality, however, it was concluded that the circumstances of the incident were an unfortunate accident and it was unlikely to be repeated.

The USEPA's Ecological Incident Information System (EIIIS) was also queried for environmental incidents related to imidacloprid that were available in that database up to November 2013. The EIIIS database contains five reports of bird deaths, seven cases of crop injury, four cases of residential plant damage, and one case involving the death of crayfish. These incident report data were incorporated into the re-evaluation of imidacloprid insecticide in the sections specific to these groups of organisms (birds, terrestrial plants, aquatic invertebrates).

Bird mortality incidents related to imidacloprid treated seed have been documented in France as part of surveillance programs (details of these incidents are provided in avian risk assessment section 4.2.1 Risks to Terrestrial Organisms: Terrestrial Vertebrates - Seed Treatments).

## **5.0 Value**

### **5.1 Value of Imidacloprid**

#### **Imidacloprid contributes to pest management in Canada.**

Imidacloprid is an insecticide registered for use on a wide range of sites to manage insect pests. It can be applied as a seed treatment, soil drench or foliar application which gives growers pest management options to help manage pests.

Imidacloprid is a systemic insecticide applied directly to seeds as a seed treatment to control soil insects such as wireworms, seed corn maggots and carrot rust fly, and leaf eating pests such as flea beetles which are difficult to control and greatly impact crop yields. For many of the listed pests there are a limited number of other seed treatments with the active ingredients clothianidin, acetamiprid and thiamethoxam all belonging to the same resistance management group as imidacloprid. Cyantraniliprole and chlorantraniliprole are also registered as seed treatments and belong to the resistance management group ryanodine receptor modulators. Additionally, cyromazine, flupyradifuron and sulfoxaflor are registered to manage listed pests on a limited number of crops.

Imidacloprid is also registered for use on beans, berries, dry pea, ginseng, grapes, herbs, hops, nuts, orchard crops, potatoes, tobacco, vegetables (greenhouse and field), ornamentals and turf as foliar spray or soil drench applications. For many of the pests on these crops there are limited numbers of other active ingredients registered for their management, and in some cases there are no alternatives for pests such as European chafer, leafhoppers, rednecked cane borer and swede midge larvae for some of the crops.

#### **Imidacloprid provides a pest management tool for important insect pests of trees.**

Imidacloprid is applied as an injection into the trunks of trees to control foliage-feeding insect pests and suppress wood-boring beetles. Imidacloprid is well suited to integrated pest management because application by trunk injection helps conserve natural enemies of pests that would be exposed to foliar applications of insecticides. It is the only active ingredient registered



for bronze birch borer and longhorn beetle. For the other listed pests, imidacloprid can be used in rotation with active ingredients from other insecticide modes of action and plays a role in delaying development of resistance in insects.

**Growers have identified imidacloprid as a priority for pest management.**

Many of the labelled uses of imidacloprid were registered through the Minor Use Program which is based on grower identified priorities. These included uses on Christmas trees, corn, fruits, mustard, ornamentals, pulses, turf and vegetables (field and greenhouse). Imidacloprid is identified as a priority by Canadian growers for registration of additional insect pests on Christmas trees, fruits, oilseed crops, ornamentals (outdoor and greenhouse), poplar trees, turf and vegetables (field and greenhouse).

**Imidacloprid has value as a Domestic Class product for the control of insects on turf.**

European chafer and European crane fly (leatherjacket) are common pests of home lawns. There are no other Domestic Class products registered to manage these pests. Active ingredients available for use by licensed applicators on residential turf are clothianidin and chlorantraniliprole.

## **6.0 Pest Control Product Policy Considerations**

### **6.1 Toxic Substances Management Policy Considerations**

The Toxic Substances Management Policy (TSMP) is a federal government policy developed to provide direction on the management of substances of concern that are released into the environment. The TSMP calls for the virtual elimination of Track 1 substances [those that meet all four criteria outlined in the policy, i.e., persistent (in air, soil, water and/or sediment), bio-accumulative, primarily a result of human activity and toxic as defined by the *Canadian Environmental Protection Act*].

During the review process, imidacloprid and its transformation products were assessed in accordance with the PMRA Regulatory Directive DIR99-03<sup>20</sup> and evaluated against the Track 1 criteria. The PMRA has reached the following conclusions:

Imidacloprid does not meet all Track 1 criteria, and is not considered a Track 1 substance. See Table 1 of Appendix XII for comparison with Track 1 criteria.

Imidacloprid does not form any transformation products that meet all Track 1 criteria.

The use of imidacloprid is not expected to result in the entry of TSMP Track-1 substances into the environment.

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<sup>20</sup> DIR99-03, The Pest Management Regulatory Agency's Strategy for Implementing the Toxic Substances Management Policy.

## Formulants and Contaminants of Health or Environmental Concern

During the review process, contaminants in the technical and formulants and contaminants in the end-use products are compared against the *List of Pest control Product Formulants and Contaminants of Health or Environmental Concern* maintained in the *Canada Gazette*<sup>21</sup>. The list is used as described in the PMRA Notice of Intent NOI2005-01<sup>22</sup> and is based on existing policies and regulations including: DIR99-03; and DIR2006-02<sup>23</sup>, and taking into consideration the Ozone-depleting Substance Regulations, 1998, of the *Canadian Environmental Protection Act* (substances designated under the Montreal Protocol). The PMRA has reached the following conclusions:

Based on the manufacturing process used, impurities of human health or environmental concern as identified in the *Canada Gazette*, Part II, Vol. 142, No. 13, SI/2008-67 (2008-06-25), including TSMP Track 1 substances, are not expected to be present in the imidacloprid products.

Imidacloprid end-use products do not contain any formulants or contaminants of health or environmental concern identified in the *Canada Gazette*.

## 7.0 Organisation for Economic Co-operation and Development Status

Canada is part of the Organisation for Economic Co-operation and Development (OECD), which groups member countries and provides a forum in which governments can work together to share experiences and seek solutions to common problems.

As part of the re-evaluation of an active ingredient, the PMRA takes into consideration recent developments and new information on the status of an active ingredient in other jurisdictions, including OECD member countries. In particular, decisions by an OECD member country to prohibit all uses of an active ingredient for health or environmental reasons are considered for relevance to the Canadian situation.

Imidacloprid is currently acceptable for use in other OECD member countries, including Australia, New Zealand and the United States. As of 6 September 2016, no decision by an OECD member country to prohibit all uses of imidacloprid for health or environmental reasons has been identified.

PMRA and USEPA are conducting a cooperative re-evaluation of pollinator risks of neonicotinoids (including imidacloprid).

<sup>21</sup> *Canada Gazette*, Part II, Volume 139, Number 24, SI/2005-114 (2005-11-30) pages 2641–2643: *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern* and in the order amending this list in the *Canada Gazette*, Part II, Volume 142, Number 13, SI/2008-67 (2008-06-25) pages 1611-1613. *Part 1 Formulants of Health or Environmental Concern, Part 2 Formulants of Health or Environmental Concern that are Allergens Known to Cause Anaphylactic-Type Reactions and Part 3 Contaminants of Health or Environmental Concern.*

<sup>22</sup> NOI2005-01, *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern under the New Pest Control Products Act.*

<sup>23</sup> DIR2006-02, PMRA Formulants Policy.

Currently, the European Commission has imposed use restrictions for imidacloprid products used as soil, foliar and seed applications to minimize exposure to bees while the European Food Safety Authority conducts an assessment of pollinator risk.<sup>24</sup>

## **8.0 Proposed Regulatory Decision**

After a thorough re-evaluation of the insecticide imidacloprid, Health Canada's PMRA, under the authority of the *Pest Control Products Act*, is proposing continued registration of certain uses of imidacloprid and removal of other uses based on environmental risks of concern that have been identified.

### **8.1 Proposed Regulatory Actions**

#### **8.1.1 Proposed Regulatory Action Related to Human Health**

Based on the human health assessment, Domestic and Commercial Class products are acceptable for continued registration. Commercial Class products require label amendments for continued registration (proposed label changes are summarized in Appendix XIII).

#### **8.1.2 Proposed Regulatory Action Related to Environment**

Based on the environmental assessment, risks of concern have been identified.

Precautionary label statements are currently on all product labels to reduce the potential for runoff to adjacent aquatic habitats. In addition, there are label restrictions prohibiting release of imidacloprid from greenhouses into surface waters. Despite these current label statements, levels of imidacloprid posing a risk to aquatic invertebrates have been found in Canadian surface waters where imidacloprid is used for pest management in agriculture (including greenhouses).

Given the risks that have been identified and considering the available information, effective risk mitigation through a use-reduction strategy would be difficult to achieve for several reasons. It would be difficult to identify the specific uses that are causing the elevated levels in water given that much of the water monitoring data were from mixed-use areas of agriculture. In addition, it is not possible to accurately predict how much use reduction would be necessary to achieve acceptable levels of imidacloprid in the environment and, therefore, any use reduction strategy would require extensive and comprehensive water monitoring information to confirm that risk reduction targets are being achieved in every use site. It is also not possible to estimate how long a reduction in environmental levels would take. In addition, in sectors where imidacloprid is approved for use but not currently used extensively, intensification of use in the future may lead to additional risks of concern. Given the above, phase-out of all outdoor agricultural, ornamental, turf, and tree uses (except tree injection uses) and greenhouse uses of imidacloprid is being proposed.

<sup>24</sup>

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:139:0012:0026:EN:PDF>

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**List of Abbreviations**

|                  |                                                                                    |
|------------------|------------------------------------------------------------------------------------|
| ♂                | males                                                                              |
| ♀                | females                                                                            |
| ↑                | increased                                                                          |
| ↓                | decreased                                                                          |
| µg               | microgram(s)                                                                       |
| µM               | micromolar                                                                         |
| 1/n              | exponent for the Freundlich isotherm                                               |
| AChE             | acetylcholinesterase                                                               |
| AChR             | acetylcholine receptor                                                             |
| AD               | administered dose                                                                  |
| ADI              | allowable daily intake level                                                       |
| a.i.             | technical active ingredient                                                        |
| ALP              | alkaline phosphatase                                                               |
| ALT              | alanine transaminase                                                               |
| ARfD             | acute reference dose                                                               |
| ASAE             | American Society of Agricultural Engineers                                         |
| AST              | aspartate aminotransferase                                                         |
| atm              | atmosphere                                                                         |
| AOX              | aldehyde oxidase                                                                   |
| BAF              | Bioaccumulation Factor                                                             |
| BCF              | Bioconcentration Factor                                                            |
| BChE             | brain cholinesterase                                                               |
| BUN              | blood urea nitrogen                                                                |
| bw or BW         | body weight                                                                        |
| bwg              | body weight gain                                                                   |
| CAF              | Composite Assessment Factor                                                        |
| CAS              | chemical abstracts service                                                         |
| CAT              | catalase                                                                           |
| CG               | crop group                                                                         |
| cm               | centimeter                                                                         |
| DBH              | diameter at breast height                                                          |
| DFOP             | double first order in parallel                                                     |
| DNIMI            | desnitro-imidacloprid                                                              |
| DNT              | developmental neurotoxicity                                                        |
| DT <sub>50</sub> | dissipation time 50% (the time required to observe a 50% decline in concentration) |
| DT <sub>90</sub> | dissipation time 90% (the time required to observe a 90% decline in concentration) |
| dw               | dry weight                                                                         |
| EC25             | effective concentration on 25% of the population                                   |
| ECG              | electrocardiogram                                                                  |
| EChE             | erythrocyte cholinesterase                                                         |
| EDE              | estimated daily exposure                                                           |
| EEC              | estimated environmental exposure concentration                                     |

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|                  |                                                                                                                           |
|------------------|---------------------------------------------------------------------------------------------------------------------------|
| EP               | end-use product                                                                                                           |
| EUP              | end-use product                                                                                                           |
| ER               | endoplasmic reticulum                                                                                                     |
| F <sub>0</sub>   | parental generation                                                                                                       |
| F <sub>1</sub>   | first filial generation                                                                                                   |
| F <sub>2</sub>   | second filial generation                                                                                                  |
| FA               | fraction of species affected                                                                                              |
| fc or FC         | food consumption                                                                                                          |
| FOB              | functional observational battery                                                                                          |
| FIR              | food ingestion rate                                                                                                       |
| FSH              | follicle-stimulating hormone                                                                                              |
| g                | gram                                                                                                                      |
| GD               | gestation day                                                                                                             |
| GFAP             | glial fibrillary acidic protein                                                                                           |
| GGT              | gamma-glutamyl transpeptidase                                                                                             |
| GI               | gastrointestinal                                                                                                          |
| GLDH             | glutamate dehydrogenase                                                                                                   |
| GPx              | glutathione peroxidase                                                                                                    |
| GSH              | glutathione                                                                                                               |
| GST              | glutathione s-transferase                                                                                                 |
| h                | hour(s)                                                                                                                   |
| ha               | Hectare                                                                                                                   |
| HC <sub>5</sub>  | Hazardous concentration estimate that is assumed to be protective of 95% of species in a species sensitivity distribution |
| HD <sub>5</sub>  | Hazardous dose estimate that is assumed to be protective of 95% of species in a species sensitivity distribution          |
| Hg               | mercury                                                                                                                   |
| HPLC             | high performance liquid chromatography                                                                                    |
| hr(s)            | hour(s)                                                                                                                   |
| IL               | interleukin                                                                                                               |
| iNOS             | inflammatory nitric oxide synthase                                                                                        |
| i.p.             | intraperitoneal                                                                                                           |
| IORE             | Indeterminate Order Rate Equation Model                                                                                   |
| IRAC             | Insecticide Resistance Action Committee                                                                                   |
| IUPAC            | International Union of Pure and Applied Chemistry                                                                         |
| iv               | intravenous                                                                                                               |
| K <sub>d</sub>   | soil-water partition coefficient                                                                                          |
| K <sub>f</sub>   | Freundlich adsorption coefficient                                                                                         |
| kg               | kilogram(s)                                                                                                               |
| K <sub>oc</sub>  | organic-carbon partition coefficient                                                                                      |
| K <sub>ow</sub>  | octanol-water partition coefficient                                                                                       |
| L                | litre(s)                                                                                                                  |
| LC <sub>50</sub> | median lethal concentration                                                                                               |
| LD               | lactation day                                                                                                             |
| LD <sub>50</sub> | median lethal dose                                                                                                        |
| LH               | luteinizing hormone                                                                                                       |
| LOAEL            | lowest observed adverse effect level                                                                                      |

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|                  |                                             |
|------------------|---------------------------------------------|
| LOEC             | lowest observed effect concentration        |
| LOD              | limit of detection                          |
| LOQ              | limit of quantitation                       |
| LR <sub>50</sub> | median lethal rate                          |
| MAS              | maximum average score                       |
| MDA              | malondialdehyde                             |
| MFO              | mixed-function oxidase                      |
| m                | metre(s)                                    |
| mg               | milligram(s)                                |
| min              | minute(s)                                   |
| MIS              | mean irritation score                       |
| mL               | millilitre(s)                               |
| mm               | millimetre(s)                               |
| MoA              | Mode of Action                              |
| MOE              | margin of exposure                          |
| mRNA             | messenger ribonucleic acid                  |
| MS               | mass spectrometry                           |
| N/A              | not applicable                              |
| nAChR            | neuronal acetylcholine receptor             |
| NADPH            | nicotinamide adenine dinucleotide phosphate |
| NC               | not calculated                              |
| ND               | not detected                                |
| ng               | nanogram(s)                                 |
| nNOS             | neuronal nitric oxide synthase              |
| NOAEL            | no observed adverse effect level            |
| NOEC             | no observed effect concentration            |
| NOEL             | no observed effect level                    |
| NOS              | nitric oxide sythase                        |
| NR               | not reported                                |
| N/R              | not required                                |
| OC               | organic carbon content                      |
| OM               | organic matter content                      |
| PChE             | plasma cholinesterase                       |
| PCPA             | <i>Pest Control Product Act</i>             |
| PCP              | Pest Control Product number                 |
| pKa              | dissociation constant                       |
| PMRA             | Pest Management Regulatory Agency           |
| PND              | post-natal day                              |
| ppb              | parts per billion                           |
| ppm              | parts per million                           |
| rel              | relative                                    |
| RER              | rough endoplasmic reticulum                 |
| RNA              | ribonucleic acid                            |
| RQ               | risk quotient                               |
| RSD              | relative standard deviation                 |
| SFO              | single first order                          |
| SGOT             | serum glutamic oxaloacetic transaminase     |

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|                  |                                               |
|------------------|-----------------------------------------------|
| SGPT             | serum glutamic-pyruvic transaminase           |
| SOD              | super oxide dismutase                         |
| SSD              | Species Sensitivity Distribution              |
| T <sub>1/2</sub> | half-life                                     |
| T3               | triiodothyronine                              |
| T4               | thyroxine                                     |
| TGAI             | technical grade active ingredient             |
| TNF              | tumor necrosis factor                         |
| T <sub>R</sub>   | representative half-life                      |
| TRR              | total radioactive residue                     |
| TSH              | thyroid stimulating hormone                   |
| TSMP             | Toxic Substances Management Policy            |
| TWA              | time weighted average                         |
| USEPA            | United States Environmental Protection Agency |
| UV               | ultraviolet                                   |
| wt(s)            | weight(s)                                     |

**Appendix I Registered imidacloprid products as of August 15, 2016  
excluding discontinued products or products with a  
submission for discontinuation**

| Registration Number | Marketing Class                   | Registrant              | Product Name                                        | Formulation type | Guarantee                                                        |
|---------------------|-----------------------------------|-------------------------|-----------------------------------------------------|------------------|------------------------------------------------------------------|
| 28936               | Technical grade active ingredient | Nufarm Agriculture Inc. | Nufarm Imidacloprid Technical                       | Solid            | Imidacloprid 98%                                                 |
| 32242               | Manufacturing concentrate         |                         | MALLET 20 MC                                        | Solution         | Imidacloprid 20%                                                 |
| 32243               | Manufacturing concentrate         |                         | NUP-14001 MUP                                       |                  | Imidacloprid 19.19%<br>Lambda-cyhalothrin 3.84%                  |
| 24468               | Technical grade active ingredient | Bayer CropScience Inc.  | Bay NTN 33893 Technical Insecticide                 | Solid            | Imidacloprid 98%                                                 |
| 25390               | Manufacturing concentrate         |                         | Merit 75% Concentrate Insecticide                   | Wettable powder  | Imidacloprid 75%                                                 |
| 24094               | Commercial                        |                         | Admire 240 Flowable Systemic Insecticide            | Suspension       | Imidacloprid 240 g/L                                             |
| 25556               |                                   |                         | Gauche 75 ST                                        | Wettable powder  | Imidacloprid 75%                                                 |
| 25636               |                                   |                         | Merit 60 WP Greenhouse And Nursery Insecticide      |                  | Imidacloprid 60%                                                 |
| 25932               |                                   |                         | Merit Solupack Insecticide                          |                  | Imidacloprid 75%                                                 |
| 25933               |                                   |                         | Merit Granular                                      | Granular         | Imidacloprid 0.5%                                                |
| 26124               |                                   |                         | Gauche 480 FL Insecticide                           | Suspension       | Imidacloprid 480 g/L                                             |
| 27170               |                                   |                         | Gauche 600 FL Insecticide                           |                  | Imidacloprid 600 g/L                                             |
| 27174               |                                   |                         | Gauche CS FL (Insecticide/Fungicide Seed Treatment) |                  | Carbathiin 47.6 g/L<br>Thiram 95.3 g/L<br>Imidacloprid 285.7 g/L |
| 27349               |                                   |                         | Genesis 240 Flowable Systemic Insecticide           |                  | Imidacloprid 240 g/L                                             |
| 27357               |                                   |                         | Intercept 60 WP Greenhouse and Nursery Insecticide  | Wettable powder  | Imidacloprid 60%                                                 |
| 27702               |                                   |                         | Admire 240 SPT Flowable Systemic Insecticide        | Suspension       | Imidacloprid 240 g/L                                             |
| 28159               |                                   |                         | Genesis MZ Potato Seed-Piece Treatment              | Dust             | Imidacloprid 1.25%<br>mancozeb 6.0%                              |
| 28160               |                                   |                         | Genesis XT Potato Seed-Piece Treatment              |                  | Imidacloprid 1.25%<br>mancozeb 6.0%<br>thiophanate-methyl 3.0%   |
| 29609               |                                   |                         | Stress Shield For Cereals                           | Suspension       | Imidacloprid 480 g/L                                             |
| 29610               |                                   |                         | Stress Shield For Cereals and Soybeans              |                  |                                                                  |
| 29611               |                                   |                         | Concept Liquid Insecticide                          | Suspension       | Imidacloprid 75 g/L<br>deltamethrin 10 g/L                       |
| 30513               |                                   |                         | Maxforce Quantum Ant Bait                           | Paste            | Imidacloprid 0.03%                                               |
| 30668               |                                   |                         | Stress Shield 600                                   | Suspension       | Imidacloprid 600 g/L                                             |



| Registration Number | Marketing Class                         | Registrant                         | Product Name                                                                                                | Formulation type | Guarantee                                     |
|---------------------|-----------------------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------|
| 30972               |                                         |                                    | Sepresto 75 WS                                                                                              | Wettable Powder  | Imidacloprid 18.75 %<br>clothianidin 56.25%   |
| 31068               |                                         |                                    | Acceleron IX-409<br>Insecticide Seed<br>Treatment                                                           | Suspension       | Imidacloprid 600 g/L                          |
| 32234               | Commercial                              | Bayer<br>CropScience<br>Inc.       | Quickbayt Granular Fly<br>Bait                                                                              | Granular         | Imidacloprid 0.5%<br>Muscalure 0.09%          |
| 29703               | Commercial +<br>Restricted              | Bayer<br>CropScience<br>Inc.       | Confidor 200 SL                                                                                             | Solution         | Imidacloprid 17.1%                            |
| 30374               | Technical<br>grade active<br>ingredient | Adama<br>Agricultural<br>Solutions | MANA Imidacloprid<br>Technical                                                                              | Solid            | Imidacloprid 98.3%                            |
| 28475               | Commercial                              | Canada Ltd.                        | Alias 240 SC Systemic<br>Insecticide                                                                        | Suspension       | Imidacloprid 240 g/L                          |
| 29130               |                                         |                                    | Quali-Pro Imidacloprid<br>75 WSP Insecticide                                                                | Wettable powder  | Imidacloprid 75%                              |
| 29185               |                                         |                                    | Quali-Pro Imidacloprid<br>0.5 Granular Insecticide                                                          | Granular         | Imidacloprid 0.5%                             |
| 30505               |                                         |                                    | Sombrero 600 FS                                                                                             | Suspension       | Imidacloprid 600 g/L                          |
| 28726               |                                         |                                    | Grapple Insecticide                                                                                         | Suspension       | Imidacloprid 240 g/L                          |
| 29048               | Commercial +<br>Restricted              | Arborjet Inc.                      | Grapple-2 Insecticide                                                                                       | Solution         | Imidacloprid 58.5 g/L<br>Imidacloprid 117 g/L |
| 31375               |                                         |                                    | IMA- Jet                                                                                                    |                  |                                               |
| 31479               |                                         |                                    | IMA-Jet 10                                                                                                  |                  |                                               |
| 25127               | Domestic                                | Bayer Inc.                         | Advantage 55 Flea and<br>Lice Adulticide for<br>Dogs 8 Weeks and<br>Older Weighing<br>between 11 and 25 Kg  | Solution         | Imidacloprid 9.1%                             |
| 25128               |                                         |                                    | Advantage 9 Flea<br>Adulticide for Cats 8<br>Weeks and Older<br>Weighing 4 Kg and<br>Under                  |                  |                                               |
| 25129               |                                         |                                    | Advantage 18 Flea<br>Adulticide for Cats 8<br>Weeks and Older<br>Weighing Over 4 Kg                         |                  |                                               |
| 25130               |                                         |                                    | Advantage 10 Flea and<br>Lice Adulticide for<br>Dogs 8 Weeks and<br>Older Weighing 4.5kg<br>& Under         |                  |                                               |
| 25131               |                                         |                                    | Advantage 100 Flea and<br>Lice Adulticide for<br>Dogs 8 Weeks and<br>Older Weighing More<br>Than 25 Kg.     |                  |                                               |
| 25132               |                                         |                                    | Advantage 20 Flea and<br>Lice Adulticide for<br>Dogs 8 Weeks and<br>Older Weighing<br>Between 4.6 and 11 Kg |                  |                                               |
| 27581               |                                         |                                    | Advantage II Small<br>Dog                                                                                   |                  | Imidacloprid 9.1%<br>pyriproxifen 0.46%       |
| 27582               |                                         |                                    | Advantage II Large<br>Dog                                                                                   |                  |                                               |

| Registration Number | Marketing Class | Registrant                       | Product Name                                                      | Formulation type | Guarantee                                           |
|---------------------|-----------------|----------------------------------|-------------------------------------------------------------------|------------------|-----------------------------------------------------|
| 27583               |                 |                                  | Advantage II Medium Dog                                           |                  |                                                     |
| 27584               |                 |                                  | Advantage II Extra Large Dog                                      |                  |                                                     |
| 27585               |                 |                                  | Advantage II small cat                                            |                  |                                                     |
| 27586               |                 |                                  | Advantage II large cat                                            |                  |                                                     |
| 27658               |                 |                                  | K9 Advantix 10 Flea, Tick and Lice Adulticide                     | Liquid           | Imidacloprid 8.8% permethrin 44%                    |
| 27659               |                 |                                  | K9 Advantix 100 Flea, Tick and Lice Adulticide                    |                  |                                                     |
| 27660               |                 |                                  | K9 Advantix 55 Flea, Tick and Lice Adulticide                     |                  |                                                     |
| 27661               |                 |                                  | K9 Advantix 20 Flea, Tick and Lice Adulticide                     |                  |                                                     |
| 29777               |                 |                                  | K9 Advantix II Small Dog                                          | Solution         | Imidacloprid 8.8% pyriproxifen 0.44% permethrin 44% |
| 29778               |                 |                                  | K9 Advantix II Medium Dog                                         |                  |                                                     |
| 29779               |                 |                                  | K9 Advantix II Extra Large Dog                                    |                  |                                                     |
| 29780               |                 |                                  | K9 Advantix II Large Dog                                          |                  |                                                     |
| 31517               |                 |                                  | Advantage II Kittens                                              | Liquid           | Imidacloprid 9.1% pyriproxifen 0.46%                |
| 31307               |                 | Fusion Animal Health Inc.        | Primidacide <4 Kg                                                 | Solution         | Imidacloprid 9.1%                                   |
| 31308               |                 |                                  | Primidacide <4.5 Kg                                               |                  |                                                     |
| 31309               |                 |                                  | Primidacide 4.6-11 Kg                                             |                  |                                                     |
| 31310               |                 |                                  | Primidacide >4 Kg                                                 |                  |                                                     |
| 31311               |                 |                                  | Primidacide >25 Kg                                                |                  |                                                     |
| 31312               |                 |                                  | Primidacide 11-25 Kg                                              |                  |                                                     |
| 31507               |                 | Brite Ridge Pharmaceuticals Inc. | Barrier 9                                                         |                  |                                                     |
| 31508               |                 |                                  | Barrier 10                                                        |                  |                                                     |
| 31509               |                 |                                  | Barrier 18                                                        |                  |                                                     |
| 31510               |                 |                                  | Barrier 55                                                        |                  |                                                     |
| 31511               |                 |                                  | Barrier 100                                                       |                  |                                                     |
| 31512               |                 |                                  | Barrier 20                                                        |                  |                                                     |
| 29738               |                 | Bayer CropScience Inc.           | Bayer Advanced <sup>TM</sup> Season Long Grub Control Insecticide | Granular         | Imidacloprid 0.25%                                  |
| 31980               | Domestic        | Wellmark International           | Zodiac Infestop Topical Solution For Cats 4 Kg and Under          | Solution         | Imidacloprid 9.1%                                   |
| 31982               |                 |                                  | Zodiac Infestop Topical Solution For Dogs 4.5 Kg and Under        |                  |                                                     |
| 31983               |                 |                                  | Zodiac Infestop Topical Solution For Dogs Between 4.6 And 11 Kg   |                  |                                                     |
| 31984               |                 |                                  | Zodiac Infestop Topical Solution For Cats Over 4 Kg               |                  |                                                     |
| 31985               |                 |                                  | Zodiac Infestop Topical Solution For Dogs Over 25 Kg              |                  |                                                     |

| Registration Number | Marketing Class | Registrant | Product Name                                                   | Formulation type | Guarantee |
|---------------------|-----------------|------------|----------------------------------------------------------------|------------------|-----------|
| 31986               |                 |            | Zodiac Infestop Topical Solution For Dogs Between 11 And 25 Kg |                  |           |

# **Appendix IIa      Registered Commercial Class Uses of Imidacloprid in Canada as of 17 August 2015**

| Site(s) <sup>1</sup>                                                                                                                                                                                                   | Pest(s)                       | Formulation Type | Application Methods and Equipment                                                                                                                                                                                         | Application Rate                                                                                                                                                            | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                                        |                               |                  |                                                                                                                                                                                                                           | Single <sup>2</sup>                                                                                                                                                         |                                                      |                                                  |
| <b>Crop group 5A</b><br>(greenhouse seedling production):<br><br>Head & Stem Brassica (including cabbage, broccoli, cauliflower, Nappa cabbage, Chinese broccoli, Brussels sprouts, Chinese mustard cabbage, kohlrabi) | Swede midge larvae            | Wettable powder  | Transplant tray plug drench                                                                                                                                                                                               | 2.46 g a.i./1000 seedlings<br><br>Early season transplants:<br>(1.24 g a.i./m <sup>2</sup> )<br><br>Mid- to late season transplants:<br>(2.1 to 3.2 g a.i./m <sup>2</sup> ) | 1/crop cycle                                         | Not applicable                                   |
| Greenhouse cucumber, tomato<br>Greenhouse eggplant                                                                                                                                                                     | Aphids, whiteflies            | Wettable powder  | Ground application:<br>chemigation:<br>soil drench using micro-irrigation, drip irrigation, overhead irrigation, or hand-held or motorized calibrated irrigation equipment<br><br>soil/soiless media hydroponic treatment | 9.6 g a.i./1000 plants                                                                                                                                                      | 1/crop cycle                                         | Not applicable                                   |
| Greenhouse lettuce (transplant seedlings)                                                                                                                                                                              | Aphids, whiteflies            | Wettable powder  | Transplant tray plug drench: drip irrigation or automated sprayer (irrigation) system                                                                                                                                     | 2.46 g a.i./1000 seedlings                                                                                                                                                  | 1/crop cycle                                         | Not applicable                                   |
| Greenhouse pepper (mature plants)                                                                                                                                                                                      | Green peach aphid, whiteflies | Wettable powder  | Ground application:<br>chemigation:<br>soil drench using micro-irrigation, drip irrigation, overhead irrigation, or hand-held or motorized calibrated irrigation equipment<br><br>soil/soiless media hydroponic treatment | 9.6 g a.i./1000 plants                                                                                                                                                      | 1/crop cycle                                         | Not applicable                                   |



| Site(s) <sup>1</sup>                                                                                                                                                             | Pest(s)                                                                                                                                 | Formulation Type | Application Methods and Equipment                                                                                                                                                                                                    | Application Rate                                                                                                                | Maximum Number of Applications per year <sup>2</sup>                                | Minimum Application Interval (Days) <sup>2</sup> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                  |                                                                                                                                         |                  |                                                                                                                                                                                                                                      | Single <sup>2</sup>                                                                                                             |                                                                                     |                                                  |
| Greenhouse Pepper (transplant seedlings)                                                                                                                                         |                                                                                                                                         |                  | Transplant tray plug drench                                                                                                                                                                                                          | 2.46 g a.i./1000 seedlings                                                                                                      |                                                                                     |                                                  |
| Greenhouse ornamentals (container plants)                                                                                                                                        | Aphids, whiteflies                                                                                                                      | Wettable powder  | Ground application: soil drench using micro-irrigation, drip irrigation, overhead irrigation, or hand-held or motorized calibrated irrigation equipment<br><br>soil/soilless media/hydroponic treatment                              | 0.002 g a.i./2.5 cm pot: 1-2 herbaceous plants/pot<br><br>0.003 g a.i./2.5 cm pot: 3+ herbaceous plants/pot or woody perennials | 1/crop cycle                                                                        | 365                                              |
| Crop group 1B: root vegetables<br><br>Carrot                                                                                                                                     | Carrot rust fly (suppression)                                                                                                           | Wettable powder  | Ground application: commercial seed treatment facilities only; seed treatment equipment<br><br>Seeds are not treated in Canada but are imported pre-treated with imidacloprid.                                                       | 0.012 to 0.023 g a.i./1000 seed                                                                                                 | 1                                                                                   | Not applicable                                   |
| Crop group 1B: Root vegetables (except sugarbeet):<br><br>Crop group 1D: Tuberous and corm vegetables (except potatoes)<br><br>Crop group 2: Leaves of root and tuber vegetables | Aphids, leafhoppers, flea beetles<br><br>Reduction in numbers of larvae of the European chafer<br><br>Aphids, leafhoppers (suppression) | Suspension       | Ground:<br>Soil application (In-furrow, soil injection or shanked or apply a narrow seed row band directly below the eventual seed row in a bedding operation 14 or fewer days before planting)<br><br>Ground:<br>foliar application | 1.88 to 2.88 g a.i./100 m of row<br><br>288 g a.i./ha<br><br>48 g a.i./ha                                                       | 1<br>(1 per crop cycle for ginseng)<br>1<br>(1 per crop cycle for ginseng)<br><br>2 | Not applicable<br><br><br>5                      |
| Globe artichoke                                                                                                                                                                  | Aphids, leafhoppers (suppression)                                                                                                       | Suspension       | Ground:<br>foliar application                                                                                                                                                                                                        | 48 g a.i./ha                                                                                                                    | 2                                                                                   | 7                                                |
| Potato                                                                                                                                                                           | Colorado potato beetle, potato leafhopper, aphids, potato flea beetle                                                                   | Suspension       | Ground application: on farm seed piece treatment equipment                                                                                                                                                                           | 6.2 g a.i./100 kg seed pieces to<br>9.4 g a.i./100 kg seed pieces                                                               | 1                                                                                   | (365)                                            |

| Site(s) <sup>1</sup>                                                                                                                                                                                     | Pest(s)                                                                                                                | Formulation Type | Application Methods and Equipment                                                                                                                                              | Application Rate                                                                            | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                          |                                                                                                                        |                  |                                                                                                                                                                                | Single <sup>2</sup>                                                                         |                                                      |                                                  |
| Potato                                                                                                                                                                                                   | Colorado potato beetle, potato leafhopper, aphids, potato flea beetle                                                  | Dust or powder   | Ground application: on farm seed piece treatment equipment                                                                                                                     | 6.25 g a.i./100 kg seed or<br>9.4 g a.i./100 kg seed                                        | (1)                                                  | (365)                                            |
| Potato                                                                                                                                                                                                   | Colorado potato beetle, aphids, leafhoppers, flea beetles                                                              | Suspension       | Ground application: soil drench (in furrow)                                                                                                                                    | 1.8 to 2.9 g a.i./100 m of row or<br>100 to 480 g a.i./ha                                   | 1                                                    | (365)                                            |
|                                                                                                                                                                                                          | Reduction in numbers of larvae of the European chafer                                                                  |                  | Ground: soil drench                                                                                                                                                            | 288 g a.i./ha                                                                               | 1                                                    | (365)                                            |
|                                                                                                                                                                                                          | Colorado potato beetle, aphids, leafhoppers (suppression)                                                              |                  | Ground application: foliar spray                                                                                                                                               | 48 g a.i./ha                                                                                | 2                                                    | 7                                                |
|                                                                                                                                                                                                          | Colorado potato beetle, aphids, leafhopper, potato flea beetle, tarnished plant bug, European corn borer (suppression) |                  | Ground application: foliar spray<br><br>Aerial application: foliar spray                                                                                                       | 49 g a.i./ha imidacloprid<br><br>6.5 g a.i./ha deltamethrin                                 | 3                                                    | 5                                                |
| <b>Crop group 3: bulb vegetables</b><br><br>Leek ( <i>Allium ampeloprasum</i> , <i>A. porrum</i> , <i>A. tricoccum</i> );<br><br>Onion, dry bulb and green ( <i>Allium cepa</i> , <i>A. fistulosum</i> ) | Onion maggot, seedcorn maggot, thrips                                                                                  | Wettable powder  | Ground application: commercial seed treatment facilities only: seed treatment equipment<br><br>Seeds are not treated in Canada but are imported pre-treated with imidacloprid. | 0.04 g a.i./1000 seed (onion - bulb, leek)<br><br>0.03 g a.i./1000 seeds (onion - bunching) | 1                                                    | Not applicable                                   |
| <b>Crop group 4A: Leafy greens subgroup of leafy vegetables (except Brassica)</b>                                                                                                                        | Aphids                                                                                                                 | Suspension       | Ground: transplant tray plug drench                                                                                                                                            | 2.45 g a.i./1000 plants                                                                     | 1                                                    | (365)                                            |
|                                                                                                                                                                                                          | Aphids                                                                                                                 |                  | Ground: soil drench - in-furrow, subsurface side dress, post seeding drench, transplant water drench, hill drench                                                              | 1.44 g a.i./100m of row                                                                     | 1                                                    | (365)                                            |
|                                                                                                                                                                                                          | Aphids, leafhopper (suppression)                                                                                       |                  | Ground: foliar spray                                                                                                                                                           | 48 g a.i./ha                                                                                | 2                                                    | 5                                                |

| Site(s) <sup>1</sup>                                                                                                                                                                        | Pest(s)                                                              | Formulation Type | Application Methods and Equipment                                                                                                                          | Application Rate                                      | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                             |                                                                      |                  |                                                                                                                                                            | Single <sup>2</sup>                                   |                                                      |                                                  |
| <b>Crop group 4A: Leafy greens</b><br><br>Lettuce (leaf and head)                                                                                                                           | Aphids, leafminer (suppression)                                      | Wettable powder  | Commercial seed treatment facilities only; seed treatment equipment<br><br>Seeds are not treated in Canada but are imported pre-treated with imidacloprid. | 0.2 g a.i./1000 seeds                                 | 1                                                    | (Not applicable)                                 |
| <b>Crop group 4B:</b><br><br>cardoon, celery, Chinese celery (fresh leaves and stalk only), celtuce, Florence fennel (including sweet anise, sweet fennel, finocchio), rhubarb, Swiss chard | Aphids                                                               | Suspension       | Ground application: soil drench – in-furrow, subsurface side dress, post seeding drench, transplant water drench, hill drench                              | 1.44 g a.i./100m of row<br><br>79.92 to 480 g a.i./ha | 1                                                    | 365                                              |
| <b>Crop Group 5 Brassica (cole) leafy vegetables</b><br><br>Broccoli and cabbage                                                                                                            | Aphids, flea beetle                                                  | Wettable powder  | Commercial seed treatment facilities only; seed treatment equipment<br><br>Seeds are not treated in Canada but are imported pre-treated with imidacloprid. | 0.3 g a.i./1000 seeds                                 | 1                                                    | (Not applicable)                                 |
| <b>Crop group 5: Brassica (cole) leafy vegetables</b>                                                                                                                                       | Aphids                                                               | Suspension       | Ground application: soil drench – subsurface side dress, post seeding drench, transplant water drench, hill drench                                         | 1.56 g a.i./100 m of row                              | 1                                                    | 365                                              |
| <b>Crop group 5: Brassica (cole) leafy vegetables</b>                                                                                                                                       | Aphids (including cabbage aphid, green peach aphid and turnip aphid) | Suspension       | Ground application: side dress application - soil injection                                                                                                | (175.2 g a.i./ha)                                     | 1                                                    | 365                                              |
|                                                                                                                                                                                             | Aphids, leafhoppers (suppression)                                    |                  | Ground application: foliar spray                                                                                                                           | 48 g a.i./ha                                          | 2                                                    | 7                                                |

| Site(s) <sup>1</sup>                                                               | Pest(s)                                                                             | Formulation Type | Application Methods and Equipment                                                                            | Application Rate                                               | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                    |                                                                                     |                  |                                                                                                              | Single <sup>2</sup>                                            |                                                      |                                                  |
| Head and stem brassica crop sub-group 5A                                           | Imported cabbageworm diamondback moth, cabbage looper, crucifer flea beetle, aphids |                  | Ground application: foliar spray                                                                             | 48.75 g a.i./ha imidacloprid<br><br>6.5 g a.i./ha deltamethrin | 3                                                    | 5                                                |
| Crop group 6: Legume vegetables (except dry soybean)                               | Aphids                                                                              | Suspension       | Ground application: in-furrow, surface band spray, post seeding drench, transplant water drench, hill drench | 1.8 g a.i./100m of row<br><br>100 to 400 g a.i./ha             | 1                                                    | (365)                                            |
| Crop group 6: Legume vegetables (except dry soybean)                               | Aphids, leafhoppers (suppression)                                                   | Suspension       | Ground: foliar application                                                                                   | 48 g a.i./ha                                                   | 2                                                    | 7                                                |
| Peanut                                                                             | Aphids                                                                              |                  | Ground application: in-furrow drench, transplant water drench, soil injection                                | 1.8 g a.i./100 m of row<br><br>100 to 400 g a.i./ha            | 1                                                    | (365)                                            |
|                                                                                    | Aphids, leafhoppers (suppression)                                                   |                  | Ground application: foliar spray                                                                             | 48 g a.i./ha                                                   | 2                                                    | 5                                                |
| Crop group 6A and C:                                                               | Potato leafhopper                                                                   |                  | Ground application: commercial seed treatment facilities and on farm seed treatment equipment                | 62.4 to 62.5 g a.i./100 kg seed                                | (1)                                                  | (365)                                            |
| Edible podded beans ( <i>Phaseolus</i> sp. and <i>Vigna</i> sp.)                   |                                                                                     |                  |                                                                                                              |                                                                |                                                      |                                                  |
| Jackbean,                                                                          | Wireworm                                                                            |                  | Ground application: commercial seed treatment facilities only: seed treatment equipment                      | 62.5 g a.i./100 kg seed                                        |                                                      |                                                  |
| Dry shelled beans ( <i>Lupinus</i> sp., <i>Phaseolus</i> sp. and <i>Vigna</i> sp.) |                                                                                     |                  |                                                                                                              |                                                                |                                                      |                                                  |
| Broad bean (fava bean)                                                             |                                                                                     |                  |                                                                                                              |                                                                |                                                      |                                                  |
| Chickpea, lentil, field pea                                                        |                                                                                     |                  | Ground application: commercial seed treatment facilities and on farm: seed treatment equipment               |                                                                |                                                      |                                                  |
| Faba bean                                                                          | Pea leaf weevil, wireworm                                                           |                  |                                                                                                              |                                                                |                                                      |                                                  |
| Field pea                                                                          | Pea leaf weevil                                                                     |                  |                                                                                                              | 62.5 to 125 g a.i./100 kg seed                                 |                                                      |                                                  |



| Site(s) <sup>1</sup>                                                                             | Pest(s)                                                                                      | Formulation Type | Application Methods and Equipment                                                                                                                                              | Application Rate                                                            | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                  |                                                                                              |                  |                                                                                                                                                                                | Single <sup>2</sup>                                                         |                                                      |                                                  |
| Soybean                                                                                          | Soybean aphid, bean leaf beetle, wireworm, seedcorn maggot, European chafer, Japanese beetle |                  | Ground application: commercial seed treatment facilities and on farm: seed treatment equipment                                                                                 | 62.5 to 125 g a.i./100 kg seed                                              | (1)                                                  | (365)                                            |
|                                                                                                  | Soybean aphid, bean leaf beetle (suppression), Japanese beetle                               |                  | Ground application: foliar spray<br><br>Aerial application: foliar spray                                                                                                       | 24.4 to 49 g a.i./ha imidacloprid<br><br>3.25 to 6.5 g a.i./ha deltamethrin | 3                                                    | 5                                                |
| <b>Crop group 8: Fruiting vegetables (except cucurbits):</b><br><br>Tomato and pepper            | Aphids, leafminer (suppression on tomato), thrips                                            | Wettable powder  | Ground application: commercial seed treatment facilities only: seed treatment equipment<br><br>Seeds are not treated in Canada but are imported pre-treated with imidacloprid. | 0.0126 g a.i./1000 seeds (tomato)<br><br>0.083 g a.i./1000 seed (pepper)    | 1                                                    | Not applicable                                   |
| <b>Crop group 8: Fruiting vegetables except cucurbits</b><br><br>(including eggplant and tomato) | Colorado potato beetle, aphids                                                               | Suspension       | Ground application: in-furrow, surface band spray, post seeding drench, transplant water drench, hill drench                                                                   | 1.68 to 2.88 g a.i./100m of row<br><br>93.36 to 559.92 g a.i./ha            | 1                                                    | (365)                                            |
|                                                                                                  | Colorado potato beetle, aphids, leafhoppers (suppression)                                    |                  | Ground application: foliar spray                                                                                                                                               | 48 g a.i./ha                                                                | 2                                                    | 5                                                |
| Eggplant                                                                                         | Colorado potato beetle                                                                       | Suspension       | Ground application:<br><br>Transplant soil application - in-furrow at transplanting or as a drench in the transplanting water or banded over the row                           | 1.68 to 2.4 g a.i./100m of row                                              | 1                                                    | (365)                                            |
|                                                                                                  |                                                                                              |                  | Ground application: foliar spray                                                                                                                                               | 48 g a.i./ha                                                                | 2                                                    | 5                                                |

| Site(s) <sup>1</sup>                                                                                                                                                                                                                   | Pest(s)                                 | Formulation Type | Application Methods and Equipment                                                                                                                                                     | Application Rate                                                        | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                                                        |                                         |                  |                                                                                                                                                                                       | Single <sup>2</sup>                                                     |                                                      |                                                  |
| Tomato                                                                                                                                                                                                                                 | Colorado potato beetle                  |                  | Ground application:                                                                                                                                                                   | 1.68 to 2.4 g a.i./100m of row                                          | 1                                                    | Not applicable                                   |
|                                                                                                                                                                                                                                        |                                         |                  | Transplant Soil application - in-furrow at transplanting or as a drench in the transplanting water or banded over the row                                                             |                                                                         |                                                      |                                                  |
|                                                                                                                                                                                                                                        | Colorado potato beetle, tomato hornworm |                  | Ground application: foliar spray                                                                                                                                                      | 48 g a.i./ha<br>49 g a.i./ha imidacloprid<br>6.5 g a.i./ha deltamethrin | 2<br>3                                               | 5<br>5                                           |
| <b>Crop Group 9<br/>Cucurbit vegetables:</b><br>Citron melon;<br>muskmelon;<br>watermelon;<br>Chayote (fruit); Chinese waxgourd;<br>cucumber;<br>gherkin; gourd, edible;<br>Momordica spp.;<br>pumpkin; squash, summer; squash, winter | Aphids, thrips                          | Wettable powder  | Ground application:<br><br>commercial seed treatment facilities only: seed treatment equipment<br><br>Seeds are not treated in Canada but are imported pre-treated with imidacloprid. | 0.25 g a.i./1000 seeds                                                  | 1                                                    | Not applicable                                   |
| <b>Crop group 9:<br/>Cucurbit vegetables</b>                                                                                                                                                                                           | Aphids                                  | Suspension       | Ground application:<br><br>soil drench: in-furrow, surface band, hill drench                                                                                                          | 1.8 g a.i./100m of row<br><br>100 to 280 g a.i./ha                      | 1                                                    | Not applicable                                   |
|                                                                                                                                                                                                                                        | Cucumber beetles                        |                  | Ground application:<br><br>soil drench: in-furrow, surface band, hill drench, subsurface side dress                                                                                   | 4.32 g a.i./100 m of row<br><br>240 to 280 g a.i./ha                    |                                                      |                                                  |
|                                                                                                                                                                                                                                        |                                         |                  | Ground application: transplant water                                                                                                                                                  | 6 g a.i./1000 plants                                                    |                                                      |                                                  |
| <b>Crop group 11:<br/>Pome fruit</b>                                                                                                                                                                                                   | Aphids (except woolly apple aphid)      |                  | Ground application:                                                                                                                                                                   | 55.2 g a.i./ha                                                          | 2                                                    | (10)                                             |
|                                                                                                                                                                                                                                        | Mullein bug                             |                  | foliar spray using airblast sprayers                                                                                                                                                  | 91.2 g a.i./ha                                                          |                                                      | 10                                               |
|                                                                                                                                                                                                                                        | Tentiform leafminer<br>Leafhoppers      |                  |                                                                                                                                                                                       | 48 g a.i./ha                                                            |                                                      | (10)                                             |

| Site(s) <sup>1</sup>                                                                                                                                                                                                                                                                                       | Pest(s)                                                                             | Formulation Type | Application Methods and Equipment                           | Application Rate                                        | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                                                                                                                            |                                                                                     |                  |                                                             | Single <sup>2</sup>                                     |                                                      |                                                  |
| Crop group 12: Stone fruit                                                                                                                                                                                                                                                                                 | Aphids (except woolly aphid)                                                        |                  | Ground application:                                         | 55.2 g a.i./ha                                          | 2                                                    | 7                                                |
|                                                                                                                                                                                                                                                                                                            | Leafhoppers                                                                         |                  | foliar spray using airblast sprayers                        | 48 g a.i./ha                                            | 2                                                    | 7                                                |
| Cherries                                                                                                                                                                                                                                                                                                   | Western cherry fruit fly, black cherry fruit fly                                    |                  | Ground application:<br>foliar spray using airblast sprayers | 55.2 g a.i./ha                                          | 5                                                    | [7]<br>10                                        |
| Crop Group 13A: cane berries                                                                                                                                                                                                                                                                               | Aphids, leafhoppers (suppression only)                                              | Suspension       | Ground application: foliar spray                            | 42 g a.i./ha                                            | 3                                                    | 7                                                |
|                                                                                                                                                                                                                                                                                                            | Reduction in numbers of white grubs (larvae of European chafer)                     |                  | Ground application: Soil drench                             | 288 g a.i./ha                                           | 1                                                    | Not applicable                                   |
| Raspberry                                                                                                                                                                                                                                                                                                  | Rednecked and raspberry caneborer (suppression)                                     |                  | Ground application: foliar spray                            | 112 g a.i./ha                                           | 3                                                    | 7                                                |
| Crop group 13B: Berry and small fruit<br>Bushberry: Berry, aronia; Blueberry, highbush, and/or hybrids of these; Blueberry, lowbush; Currant, buffalo, black, and red; Elderberry; Gooseberry; Cranberry (highbush); Honeysuckle; Huckleberry; Jostaberry; and Junberry (Service berry or Saskatoon berry) | Reduction in numbers of white grubs (larvae of European chafer and Japanese beetle) |                  | Ground application: field drench                            | 288 g a.i./ha                                           | 1                                                    | (365)                                            |
|                                                                                                                                                                                                                                                                                                            | Aphids, leafhoppers (suppression)                                                   |                  | Ground application: foliar spray                            | 42 g a.i./ha                                            | 2                                                    | 7                                                |
|                                                                                                                                                                                                                                                                                                            | Blueberry maggot                                                                    |                  |                                                             | 55.2 to 84 g a.i./ha                                    |                                                      |                                                  |
|                                                                                                                                                                                                                                                                                                            | Japanese beetle adult                                                               |                  |                                                             | 84 g a.i./ha                                            |                                                      |                                                  |
| Saskatoon berry                                                                                                                                                                                                                                                                                            | Woolly elm aphid (suppression), woolly apple aphid (suppression)                    |                  | Ground application: field drench (band spray)               | 0.03 g/plant                                            | 1                                                    | (365)                                            |
| Crop group 13F: Berry and small fruit vine including grapes                                                                                                                                                                                                                                                | Leafhoppers                                                                         |                  | Ground application: sub-surface side dress, hill drench     | 1.8 to 2.88 g a.i./ 100m of row<br>100 to 480 g a.i./ha | 1                                                    | (365)                                            |

| Site(s) <sup>1</sup>                                                                                                                                                                                      | Pest(s)                                                         | Formulation Type | Application Methods and Equipment                                   | Application Rate Single <sup>2</sup>                                                                                          | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                           |                                                                 |                  | Ground application: foliar spray                                    | 48 g a.i./ha                                                                                                                  | 2                                                    | 14                                               |
| Blueberry (lowbush and highbush)                                                                                                                                                                          | Blueberry aphid                                                 |                  | Ground application: foliar spray                                    | 42 g a.i./ha imidacloprid<br>5.6 g a.i./ha deltamethrin                                                                       | 3                                                    | 5                                                |
| <b>Crop group 13G: Berry and small fruit low growing berries including:</b><br>bearberry;<br>bilberry;<br>blueberry lowbush;<br>cloudberry;<br>lingonberry;<br>muntries;<br>partridgeberry;<br>strawberry | Aphids                                                          | Suspension       | Ground application: surface band spray                              | 1.8 to 2.88 g a.i./100m of row<br>100 to 480 g a.i./ha<br>204 to 312 g a.i./ha                                                | 1                                                    | (365)                                            |
|                                                                                                                                                                                                           | Strawberry aphid (on strawberry only)                           |                  |                                                                     |                                                                                                                               |                                                      |                                                  |
|                                                                                                                                                                                                           | Reduction in numbers of white grubs (larvae of European chafer) |                  | Ground application: soil drench                                     | 288 g a.i./ha                                                                                                                 | 1                                                    | (365)                                            |
|                                                                                                                                                                                                           | Aphids, leafhoppers (suppression)                               |                  | Ground application: foliar spray                                    | 42 g a.i./ha                                                                                                                  | 2                                                    | Not stated                                       |
|                                                                                                                                                                                                           | Cranberry                                                       |                  | Ground application: soil drench                                     | 288 g a.i./ha                                                                                                                 | 1                                                    | (365)                                            |
| <b>Crop group 14: Tree nuts plus Pistachio</b>                                                                                                                                                            | Aphids (except woolly apple aphid)                              | Suspension       | Ground application: foliar spray<br>airblast sprayer                | 55.2 g a.i./ha                                                                                                                | 2                                                    | 6                                                |
|                                                                                                                                                                                                           | leafhoppers (suppression)                                       |                  |                                                                     | 48 g a.i./ha                                                                                                                  |                                                      |                                                  |
| Barley, oats, wheat                                                                                                                                                                                       | Wireworm                                                        | Suspension       | Ground application: commercial and on farm seed treatment equipment | 10 to 30 g a.i./100 kg seed for early season crop protection<br>20 to 30 g a.i./100 kg seed in fields with high pest pressure | (1)                                                  | (365)                                            |
| Field corn (seed production only),                                                                                                                                                                        | Corn flea beetle                                                | Suspension       | Ground application: commercial seed treatment equipment             | 48 g a.i./80 000 seeds                                                                                                        | (1)                                                  | (365)                                            |
| Field corn (including seed production)                                                                                                                                                                    | Wireworm                                                        |                  | Ground application: commercial and on farm seed treatment equipment | 13 g a.i./80 000 seeds                                                                                                        |                                                      |                                                  |
| Sweet corn (Ontario and Québec only)                                                                                                                                                                      | Corn flea beetle                                                |                  |                                                                     | 250 g a.i./100 kg seed                                                                                                        |                                                      |                                                  |
|                                                                                                                                                                                                           | Wireworm                                                        |                  |                                                                     | 67.2g a.i./100 kg seed                                                                                                        |                                                      |                                                  |



| Site(s) <sup>1</sup>                                                                                                                    | Pest(s)                                                        | Formulation Type            | Application Methods and Equipment                                                     | Application Rate Single <sup>2</sup>                                                                                                                                                                                                                            | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
| <b>Crop group 19A: Herbs</b>                                                                                                            | Aphids                                                         | Suspension                  | Ground application: in-furrow drench, transplant water drench, soil injection         | 1.44 g a.i./100 m of row<br>79.92 to 480 g a.i./ha                                                                                                                                                                                                              | 1                                                    | (365)                                            |
|                                                                                                                                         | Aphids, leafhoppers (suppression)                              |                             | Ground application: foliar spray                                                      | 48 g a.i./ha                                                                                                                                                                                                                                                    | 2                                                    | 5                                                |
| Hops                                                                                                                                    | Aphids                                                         | Suspension                  | Ground Application: foliar spray                                                      | 55.2 g a.i./ha                                                                                                                                                                                                                                                  | 2                                                    | 28                                               |
| Canola, mustard (condiment type only), rapeseed                                                                                         | Flea beetle                                                    | Wettable powder, suspension | Ground application: commercial seed treatment equipment                               | 400-802 g a.i./ 100 kg seed                                                                                                                                                                                                                                     | (1)                                                  | (365)                                            |
| Mustard (oilseed type)                                                                                                                  |                                                                | Suspension                  |                                                                                       | 400 g a.i./100 kg seed or 800 g a.i./100 kg seed                                                                                                                                                                                                                |                                                      |                                                  |
| Tobacco                                                                                                                                 | Aphids                                                         | Suspension                  | Ground application: foliar spray                                                      | 48 g a.i./ha                                                                                                                                                                                                                                                    | 2                                                    | 7                                                |
|                                                                                                                                         | Aphids, flea beetles                                           |                             | Ground application: in-furrow drench, transplant water drench, sub-surface side dress | 2.04 g a.i./100m of row<br>113.28 to 453.36 g a.i./ha                                                                                                                                                                                                           | 1                                                    | (365)                                            |
| Residential, commercial, industrial, institutional and agricultural structures (indoors only)<br><br>Various transport vehicles.        | Cockroach<br><br>(German, brown-banded, American and Oriental) | Paste                       | Ground application: Gel bait – spot and crack/crevice treatment                       | Light infestations: 1 placement (i.e., 0.1g of gel) per m <sup>2</sup> or linear meter.<br><br>Moderate to heavy infestations: 2 placements<br><br>0.66/215/m <sup>2</sup> for light infestations<br><br>or<br><br>0.0044/m <sup>2</sup> for heavy infestations | Not stated                                           | 28                                               |
| Residential, commercial, industrial, institutional and agricultural structures (Indoors and outdoors)<br><br>Various transport vehicles | Ants<br><br>(excluding fire, harvester and carpenter ants)     | Liquid                      | Bait station and crack/crevice                                                        | crack/crevice treatment: 6x10 <sup>-5</sup> g a.i./ m<br><br>bait station: 6x10 <sup>-4</sup> g a.i./bait station<br><br>Maximum of 6x10 <sup>-3</sup> g a.i. /100m <sup>2</sup>                                                                                | Not stated                                           | Not stated                                       |
| Christmas trees                                                                                                                         | Balsam twig aphid                                              | Suspension                  | Ground application: airblast sprayer                                                  | 60 g a.i./ha                                                                                                                                                                                                                                                    | 2                                                    | 7                                                |

| Site(s) <sup>1</sup>                                                                                                                                | Pest(s)                                                  | Formulation Type | Application Methods and Equipment   | Application Rate            | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|------------------|-------------------------------------|-----------------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                     |                                                          |                  |                                     | Single <sup>2</sup>         |                                                      |                                                  |
| Albizia, ash, birch, box elder, buckeye, elm, hackberry, horse chestnut, maple, mountain ash, poplar, silk tree, sycamore/London plane tree, willow | Asian longhorned beetle (suppression)                    | Solution         | Ground application: trunk injection | 0.09 to 0.19 g a.i./cm DBH  | 1                                                    | (365)                                            |
| Birch, elm, hackberry, horse chestnut, maple, mountain ash, poplar, silk tree, sycamore/London plane, willow                                        | Asian longhorned beetle (suppression)                    | Solution         | Ground application: trunk injection | 0.257 g a.i./cm DBH         | 1                                                    | (365)                                            |
| Spruce                                                                                                                                              | Brown spruce longhorn beetle (suppression)               |                  |                                     |                             |                                                      |                                                  |
| Ash                                                                                                                                                 | Emerald ash borer (suppression)<br>cottony ash psyllid   |                  |                                     | 0.09 to 0.275 g a.i./cm DBH |                                                      |                                                  |
| Birch                                                                                                                                               | Bronze birch borer (suppression)                         |                  |                                     | 0.062 g a.i./cm DBH         |                                                      |                                                  |
| Elm                                                                                                                                                 | European elm scale, elm leafminer                        |                  |                                     |                             |                                                      |                                                  |
| Hemlock                                                                                                                                             | Hemlock woolly adelgid                                   |                  |                                     |                             |                                                      |                                                  |
| Black locust                                                                                                                                        | Locust leafminer                                         |                  |                                     |                             |                                                      |                                                  |
| Ornamental apple                                                                                                                                    | Woolly apple aphid                                       |                  |                                     |                             |                                                      |                                                  |
| Ornamentals (field grown)<br><br>including herbaceous perennials, ornamental grasses, trees, shrubs                                                 | European chafer (larvae)<br><br>Japanese beetle (larvae) | Wettable powder  | Ground application: soil drench     | 280 g a.i./ha               | 1                                                    | (365)                                            |

| Site(s) <sup>1</sup>                                                                                                                                                                                   | Pest(s)                                 | Formulation Type                        | Application Methods and Equipment                          | Application Rate    | Maximum Number of Applications per year <sup>2</sup> | Minimum Application Interval (Days) <sup>2</sup> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------------|------------------------------------------------------------|---------------------|------------------------------------------------------|--------------------------------------------------|
|                                                                                                                                                                                                        |                                         |                                         |                                                            | Single <sup>2</sup> |                                                      |                                                  |
| Ornamentals (container grown)<br><br>including herbaceous perennials, ornamental grasses, trees, shrubs                                                                                                |                                         |                                         |                                                            |                     |                                                      |                                                  |
| Turf<br><br>(home lawns, business and office complexes, shopping complexes, multi-family residential complexes, airports, cemeteries, parks, playgrounds, athletic fields, golf courses and sod farms) | European chafer (larvae)                | Wettable powder (in water soluble bags) | Ground application: boom sprayer, etc.                     | 281.25 g a.i./ha    | 1                                                    | (365)                                            |
|                                                                                                                                                                                                        | Japanese beetle (larvae)                |                                         |                                                            |                     |                                                      |                                                  |
|                                                                                                                                                                                                        | Ataenius beetle (larvae)                | Granular                                | Ground application: granular spreader drop and rotary type | 280 g a.i./ha       | 1                                                    | (365)                                            |
|                                                                                                                                                                                                        | European crane fly larvae (suppression) |                                         |                                                            |                     |                                                      |                                                  |

<sup>1</sup> Crop groups are identified as listed on the end use product labels and may not be identical to the crop groups listed on the Health Canada Residue Chemistry Crop Groups website: <http://hc-sc.gc.ca/cps-spc/pest/part/protect-protector/food-nourriture-rece-reper-eng.php>

<sup>2</sup> All information is from the registered labels except where the minimum application interval for cherries supported by the registrants is indicated by square brackets [ ]. Information added by the PMRA is indicated by round brackets ( ).

**Appendix IIb      Registered Domestic Class Uses of Imidacloprid in  
Canada as 8 October 2015**

| Site(s) | Pest(s)                                                                                                                | Formulation Type | Application Methods and Equipment | Application Rate (a.i.)                 |                    | Maximum Number of Applications per Year | Minimum Number of Days Between Applications |
|---------|------------------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------|-----------------------------------------|--------------------|-----------------------------------------|---------------------------------------------|
|         |                                                                                                                        |                  |                                   | Maximum Single <sup>1</sup>             | Maximum Cumulative |                                         |                                             |
| Cat     | Fleas                                                                                                                  | Solution         | Spot on treatment                 | 0.04 to 0.08 g a.i./spot on application | Not stated         | Not stated                              | 7 days                                      |
| Dog     | Fleas, ticks                                                                                                           | Liquid, solution | Spot on treatment                 | 0.04 to 0.4 g a.i./spot on application  | Not stated         | Not stated                              | 7 days                                      |
| Turf    | Larval stages of:<br>European chafer,<br>Japanese beetle,<br>black turfgrass<br>ataenius beetle,<br>European crane fly | Granular         | Granular broadcast spreaders      | 280 g/ha                                | 280 g/ha           | 1                                       | 365                                         |





## Appendix III Toxicological Information for Human Health Risk Assessment

**Table 1 Toxicity Profile of Imidacloprid**

NOTE: Effects noted below are known or assumed to occur in both sexes unless otherwise noted; in such cases, sex-specific effects are separated by semi-colons. Effects on organ weights are known or assumed to reflect changes in absolute weight and relative (to bodyweight) weight unless otherwise noted.

| Study Type/ Animal/<br>PMRA#                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Study Results |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>TOXICOKINETICS (PMRA# 1155769, 1155781, 1155782, 2030947)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| Investigations into the toxicokinetic behaviour of imidacloprid were conducted using the parent compound radio-labelled at either the methylene or imidazolidine position.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |               |
| <p><b>Rate and extent of absorption and excretion:</b> Both methylene-labelled imidacloprid ([Methylene-<sup>14</sup>C] Imidacloprid) and imidazolidine-labelled imidacloprid ([Imidazolidine-4,5-<sup>14</sup>C] Imidacloprid) were rapidly absorbed with approximately 90% of the administered dose (AD) being eliminated within 24 hours. There were no biologically significant differences between sexes, dose levels, or routes of administration. Urinary excretion was the major route of elimination regardless of radio-label position (70-91% of AD), with a lesser amount eliminated in faeces (7-25% of AD). Biliary excretion was a major contributor to faecal radioactivity; only 5% of AD was excreted in faeces in bile-fistulated animals administered the methylene-labelled compound. Only a trace amount was excreted in expired air regardless of radio-label position. For methylene-labelled imidacloprid, the maximum plasma concentration occurred between 1.1 and 2.5 hours, and elimination half-lives were 3 and 26-118 hours. For imidazolidine-labelled compound, the maximum plasma concentration was measured between 1 and 4 hours, and elimination half-lives ranged between 9 and 25 hours.</p> |               |
| <p>Methylene-labelled nitrosimine, a nitroso derivative of imidacloprid formed during pretreatment (chronic oral dosing), showed a toxicokinetic pattern similar to that of methylene-labelled imidacloprid. However, more radioactivity was found in tissues of those animals receiving methylene-labelled imidacloprid (0.9%-3.4% of AD) than those receiving methylene-labelled nitrosimine (0.2% of AD).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| <p><b>Distribution / target organ(s):</b> Total tissue burden of methylene-labelled imidacloprid after 48 hours accounted for approximately 0.5% of the AD, with major sites of accumulation being the liver, kidney, lung, skin, and plasma and minor sites being the brain and testes. Total tissue burden of imidazolidine-labelled imidacloprid accounted for approximately 1% of the AD, with the major sites being the liver, kidney, lung, and skin and the minor sites being the brain and muscle.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |               |
| <p>The major sites of accumulation for methylene-labelled nitrosimine included the lung, renal fat, liver, and kidney, with minor sites being the testes and brain.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |               |
| <p><b>Biotransformation:</b> These studies identify two main routes of metabolism responsible for the degradation of imidacloprid. The first involves hydroxylation of the imidazolidine ring followed by oxidative cleavage to yield 6-chloronicotinic acid and its glycine conjugate. Dechlorination of this metabolite produces 6-hydroxynicotinic acid and its mercapturic acid derivative. Hydroxylation of the imidazolidine ring can also be followed by the elimination of water to give an olefinic metabolite. The second pathway involves nitroreduction to yield nitrosimine, amino-guanidine derivatives and desnitro-imidacloprid. Desnitro-imidacloprid undergoes oxidative cleavage to imidazolidine and 6-chloronicotinic acid and its glutathione conjugates.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |

| Study Type/ Animal/<br>PMRA#                                                                                                                    | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Neonicotinoid<br>nitroreductase<br>identification in rabbit<br>liver cytosol<br><br>PMRA# 2418100                                               | Supplemental<br><br>As part of the metabolic pathway, imidacloprid undergoes nitroreduction to form nitrosoguanidine and aminoguanidine. The molybdo-flavoenzyme aldehyde oxidase (AOX) was identified as the neonicotinoid nitroreductase in rabbit liver cytosol. Large species differences are observed in imidacloprid nitroreductive activity of liver cytosol. Nitroreduction to aminoguanidine was high in rabbit, moderate in monkey, human and rat and low in mouse, cow, dog, cat and chicken. Nitroreduction to nitrosoguanidine was moderate in all species except dog, cat and chicken (low).                                                                                                                                                                              |
| In vitro metabolism in<br>Human P450<br>Supersomes (baculovirus<br>infected insect cells<br>containing human P450<br>cDNA)<br><br>PMRA# 2418124 | Supplemental<br><br>Principal organoextractable NADPH-dependent metabolites are the 5-hydroxy (major) and olefin (minor) derivatives from hydroxylation and desaturation of the imidazolidine moiety and the nitrosoimine (major), guanidine (minor) and urea (trace) derivatives from reduction and cleavage of the nitroimine substituent. Isoenzyme activity selective for imidazolidine oxidation: CYP3A4>CYP2C19 or CYP2A6>CYP2C9. Isoenzyme activity selective for nitrosimine reduction: CYP1A2>CYP2B6> CYP2D6>CYP2E1. Flavin monooxygenases not active.                                                                                                                                                                                                                         |
| Absorption in human<br>intestinal CaCo-2 cell<br>line<br><br>PMRA# 2418098                                                                      | Supplemental<br><br>Imidacloprid crossed the transepithelial layer very quickly and completely. Data suggests imidacloprid strongly absorbed by inward and outward active transporters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Metabolism in Swiss<br>Webster mice<br>(intraperitoneal)<br><br>PMRA# 2418108                                                                   | Supplemental<br><br>Peak levels of imidacloprid at 15 min post-dosing in brain (6 ppm) liver (18 ppm) and plasma (8 ppm), half-life was 90, 30 and 80 min in brain, liver and plasma, respectively. Liver metabolites included desnitro-imidacloprid, nitrosimine-imidacloprid, aminoguanidine-derivative, methyltriazinone derivative of aminoguanidine, olefin-imidacloprid, 5-hydroxy-imidacloprid and 4,5-dihydroxy-imidacloprid. Brain metabolites included desnitro-imidacloprid and nitrosimine-imidacloprid. Plasma metabolites included nitrosimine-imidacloprid, olefin-imidacloprid and 5-hydroxy-imidacloprid. Urine (0-24 hr) contained imidacloprid (22%) and 5-hydroxy-imidacloprid (22%) and lesser metabolites (<5%). Feces (0-24 hr) had <0.01% of administered dose. |
| Metabolism (i.p. dosing)<br>♂ Swiss Webster mice<br>♂ DBA2 mice<br>♂ CD-1 mice<br><br>PMRA# 2418126                                             | Supplemental: i.p. dosing<br><br>↓ nitrosimine-imidacloprid and desnitro-imidacloprid in Swiss Webster mice with chemically-reduced (tungsten or hydralazine) AOX activity and in AOX-deficient DBA2 mice.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Blood and coat residue<br>study<br>(single dermal<br>application)<br><br>Dog<br><br>PMRA# 2417849                                               | Supplemental; 9.1% pure (Advantage formulation)<br><br><b>364 mg/dog:</b> Blood and glove wipe samples were collected from dogs 24h, 72h and then weekly for 5 weeks post application. Peak imidacloprid residues were detected in blood (54 ppb) and gloves (254 ppm) at 24h postapplication. Residues detected in blood at 72h postapplication were 19 ppb, and were not detected after 1 week postapplication. Residues detected in glove samples were low by the 4 <sup>th</sup> week (0.08 ppm) and not detected by the 5 <sup>th</sup> week.                                                                                                                                                                                                                                      |

| Study Type/ Animal/<br>PMRA#                             | Study Results                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ACUTE STUDIES - Technical Imidacloprid</b>            |                                                                                                                                                                                                                                                                                                                                                                                    |
| Oral<br><br>Wistar rat<br><br>PMRA# 2030939              | <p>LD<sub>50</sub> (♂) = 642 mg/kg bw; LD<sub>50</sub> (♀) = 648 mg/kg bw</p> <p>Clinical signs included apathy, staggering or spastic gait, labored breathing, spasms or transient spasms, transient tremors, decreased motility, increased water intake, diuresis, piloerection, hypersalivation, absence of feces and transient convulsions</p> <p><b>MODERATE TOXICITY</b></p> |
| Oral<br><br>Wistar rat<br><br>PMRA# 2030940              | <p>LD<sub>50</sub> (♂) = 504 mg/kg bw; LD<sub>50</sub> (♀) = 379 mg/kg bw</p> <p>Clinical signs included apathy, staggering and spastic gait, labored breathing, reduced motility, spasmodic state (periodic in some cases), periodic tremors, soft feces and piloerection</p> <p><b>HIGH TOXICITY</b></p>                                                                         |
| Oral<br><br>Wistar rat<br><br>PMRA# 1155724              | <p>LD<sub>50</sub> (♂) = 424 mg/kg bw ; LD<sub>50</sub> (♀) = 450-475 mg/kg bw</p> <p>Clinical signs at ≥ 100 mg/kg bw (♂) or 250 mg/kg bw (♀): ↓ motility, apathy, breathing disturbances, staggered gait, narrowed palpebral fissures, transient trembling and/or spasms (resolved 2-6 days).</p> <p><b>HIGH TOXICITY</b></p>                                                    |
| Dermal<br><br>Wistar rat<br><br>PMRA# 1155729            | <p>LD<sub>50</sub> (♂/♀) &gt; 5000 mg/kg bw</p> <p>No clinical signs of toxicity or abnormal findings at necropsy; ↓ bwg (♀).</p> <p><b>LOW TOXICITY</b></p>                                                                                                                                                                                                                       |
| Inhalation<br><br>Wistar rat<br><br>PMRA# 1155720        | <p>LC<sub>50</sub> (♂/♀) &gt; 0.069 mg/L (Acrosol)</p> <p>LC<sub>50</sub> (♂/♀) &gt; 5.32 mg/L (Dust)</p> <p>Clinical signs in rats exposed to dust for 4 hours at ≥ 2.58 mg/L: laboured breathing, decreased motility, piloerection; slight tremors were noted 1-2 hrs post-dosing at 5.32 mg/L; signs resolved by day 1.</p> <p><b>LOW TOXICITY</b></p>                          |
| Eye Irritation<br><br>NZW Rabbit<br><br>PMRA# 1155731    | <p>MAS = 0<br/>MIS = 6 at 1 hr</p> <p><b>Minimally irritating</b></p>                                                                                                                                                                                                                                                                                                              |
| Dermal Irritation<br><br>NZW Rabbit<br><br>PMRA# 1155733 | <p>MAS = 0<br/>MIS = 1 at 1 hr</p> <p><b>Non-irritating</b></p>                                                                                                                                                                                                                                                                                                                    |



| Study Type/ Animal/<br>PMRA#                                                         | Study Results                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Skin Sensitization-<br>(Maximization)<br><br>Hartley Guinea pig<br><br>PMRA# 1155747 | <b>Not a dermal sensitizer</b>                                                                                                                                                                                                                                                                                                          |
| <b>ACUTE STUDIES – Desnitro-imidacloprid (mammalian metabolite)</b>                  |                                                                                                                                                                                                                                                                                                                                         |
| Oral<br><br>Sprague Dawley rat<br><br>PMRA# 2030936                                  | LD <sub>50</sub> (♂) = 300 mg/kg bw ; LD <sub>50</sub> (♀) = 280 mg/kg bw<br><br>Clinical signs ≥ 95 mg/kg bw included sedation, ptosis, abnormal respiration, abnormal gait, tremors (both sexes)<br><br><b>HIGH TOXICITY</b>                                                                                                          |
| <b>ACUTE STUDIES – Urea-imidacloprid (mammalian metabolite)</b>                      |                                                                                                                                                                                                                                                                                                                                         |
| Oral<br><br>Sprague Dawley rat<br><br>PMRA# 2030937                                  | LD <sub>50</sub> (♂) = 4080 mg/kg bw; LD <sub>50</sub> (♀) = 1820 mg/kg bw<br><br>Clinical signs included mydriasis, abnormal gait, sedation, nasal bleeding, abnormal respiration, salivation, tremors<br><br><b>SLIGHT TOXICITY</b>                                                                                                   |
| <b>ACUTE STUDIES – Olefin-imidacloprid (mammalian metabolite)</b>                    |                                                                                                                                                                                                                                                                                                                                         |
| Oral<br><br>Sprague Dawley rat<br><br>PMRA# 2030938                                  | LD <sub>50</sub> (♂) = 3500 mg/kg bw; LD <sub>50</sub> (♀) = 1100 mg/kg bw<br><br>Clinical signs ≥ 440/200 mg/kg bw included mydriasis, tremors, abnormal respiration, lacrimation, red tears, emaciation, abnormal gait, red urine and piloerection<br><br><b>SLIGHT TOXICITY</b>                                                      |
| <b>ACUTE STUDIES – Nitrosimine-imidacloprid (mammalian metabolite)</b>               |                                                                                                                                                                                                                                                                                                                                         |
| Oral<br><br>Sprague Dawley rat<br><br>PMRA# 2417845                                  | LD <sub>50</sub> (♂) = 1980 mg/kg bw ; LD <sub>50</sub> (♀) = 3560 mg/kg bw<br><br>Clinical signs at ≥ 980 mg/kg bw included mydriasis, tremors, sedation, exophthalmos, abnormal respiration, convulsions, red lacrimation, nasal bleeding, emaciation, and/or abnormal gait. All signs resolved by day 9.<br><br><b>HIGH TOXICITY</b> |
| <b>SHORT TERM TOXICITY</b>                                                           |                                                                                                                                                                                                                                                                                                                                         |
| 21-day dermal<br><br>NZW rabbit<br><br>PMRA# 1155690                                 | NOAEL > 1000 mg/kg bw/day; LOAEL not established<br><br>There were no treatment-related findings.                                                                                                                                                                                                                                       |

| Study Type/ Animal/<br>PMRA#                                               | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28-day inhalation<br><br>Wistar rat<br><br>PMRA# 1155689                   | NOAEL = 0.031 mg/L (equivalent to 8.4 mg/kg bw/day)<br><br>No mortalities; no clinical signs of toxicity.<br><br><b>0.031 mg/L (8.4 mg/kg bw/day)</b> - ↑ hepatic MFO activity (♀) considered non-adverse.<br><br><b>0.191 mg/L (51.8 mg/kg bw/day)</b> -<br>↑ GLDH, ↓ triglyceride, ↑ MFO; ↑ cytochrome P450 (♂); ↑ liver wt, ↑ AST, ↑ ALT, ↑ ALP, ↑ coagulation time (♀).                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 96-day dietary<br><br>Wistar rat<br><br>PMRA# 1155682                      | NOAEL = 150 ppm (14/20.3 mg/kg bw/day; ♂/♀)<br><br><b>≥600 ppm (60.9/83.3 mg/kg bw/day):</b><br>↓ calcium; ↓ bw (♂); ↓ total leukocytes (♀).<br><br><b>2400 ppm (300/422 mg/kg bw/day):</b><br>↓ bwg, ↓ fc, ↓ water intake, ↓ food conversion efficiency, ↓ protein, ↓ albumin, ↓ bilirubin, and ↓ platelets, ↑ ALP, ↑ thromboplastin time, ↑ brain cholinesterase activity; single cell and focal necrosis, inflammatory infiltration, cytoplasmic transformation swollen nuclei in liver, ↑ ALT, ↑ AST, ↑ BUN, ↑ blood creatinine, ↑ urinary protein, ↑ protein/ creatinine ratio, ↓ triglycerides, ↓ cholesterol, ↓ urinary creatinine (♂); ↓ bw (♀).<br><br><b>Recovery group:</b> ↓ bw, ↑ fc, ↓ protein, ↑ thromboplastin time, ↑ brain cholinesterase activity                                                         |
| 4-week dietary<br><br>Beagle dog<br><br>Range-finding<br><br>PMRA# 1155691 | Supplemental. NOAEL not established.<br><br><b>≥1000 ppm (31 mg/kg bw/day):</b> transient ↓ in fc, ↑ cytochrome P450 (not assessed at higher dose), hepatocellular hypertrophy, pigmentation of the Kupffer cells, thyroid follicular atrophy; ↑ liver wt in one ♀.<br><br><b>5000 ppm (49 mg/kg bw/day):</b> all animals died or sacrificed moribund (1% died day 2, 1 & died day 18, 2/sex sacrificed day 24), vomiting, ataxia, tremors, body weight loss, ↓ fc, ↑ BUN, ↑ bilirubin, ↑ GGT, ↓ triglycerides, ↓ lipids, ↓ ALP, ↓ α-1 globulin, ↓ T3, reddening, congestion, and discolouration of GI tract, red-brown cysts and valvular telangiectasis in the heart, ↓ zymogen content in the pancreas, tubular degeneration in the testes, thymic involution, acinar atrophy of the salivary gland, bone marrow atrophy. |
| 90-day dietary<br><br>Beagle dog<br><br>PMRA# 1155681                      | NOAEL = 200 ppm (7.7/8.0 mg/ kg bw/day; ♂/♀)<br><br><b>600 ppm (22.1/24.8 mg/kg bw/day):</b> trembling (all animals first week of dosing) and slightly emaciated animals.<br><br><b>1800-1200 ppm (45.0/45.7 mg/kg bw/day):</b> trembling (all animals week 1 to 5) and severe tremors (all animals week 1, 1 ♀ week 3), ↓ fc and water consumption (1 <sup>st</sup> 3 weeks), emaciated animals and decreased urinary volumes.<br><br>No effect on thyroid pathology, TSH, T3 or T4                                                                                                                                                                                                                                                                                                                                         |

| Study Type/ Animal/<br>PMRA#                                                 | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| 12-month dietary<br><br>Beagle dog<br><br>PMRA# 1155758                      | NOAEL > 1200- 2500 ppm (40-72/42-72 mg/kg bw/day; ♂/♀)<br>LOAEL not established<br><br><b>1200-2500 ppm (40-72 mg/kg bw/day):</b> non-adverse findings: transient ↓ in fc, ↑ hepatic cytochrome P450 (not assessed at lower doses); ↑ cholesterol (♀).<br><br>No effect on thyroid pathology.<br><br>A 2-week follow-up study, designed to resolve discrepancies between 90-day and 12-month studies, revealed no clinical signs (no trembling) in 2/dogs/sex dosed at 1200 ppm.                                                                                                                                            |
| <b>SHORT TERM TOXICITY – Nitrosimine-imidacloprid (mammalian metabolite)</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 12-week drinking water<br><br>Wistar Bor rat<br><br>PMRA# 1155695            | NOAEL = 100 ppm (13 mg/kg bw/day)<br><br><b>300 ppm (35/39 mg/kg bw/day):</b><br>Final sacrifice: ↑ lymphocytes and ↓ polymorphonuclear cells<br><br><b>1000 ppm (106/117 mg/kg bw/day):</b> ↓ water intake<br><u>Interim sacrifice:</u> ↓ thymus wt, ↑ relative heart and kidney wt (♂); ↓ thromboplastin time, ↓ relative spleen wt (♀)<br><u>Final sacrifice:</u> ↑ relative kidney wt; ↓ absolute liver wt, ↓ adrenal gland wt (♂); ↓ sodium, ↓ reticulocyte count, ↓ spleen wt (♀)                                                                                                                                     |
| <b>CHRONIC TOXICITY AND ONCOGENICITY</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 2-year dietary<br><br>Wistar rat<br><br>PMRA# 1155757,<br>1155760, 1155761   | NOAEL = 100 ppm (5.7 mg/kg bw/day)(♂); 300 ppm (24.9 mg/kg bw/day)(♀)<br><br><b>≥300 ppm (16.9 mg/kg bw/day):</b> ↑ incidence of mineralized particles in colloid of isolated thyroid follicles (♂).<br><br><b>≥900 ppm (51.3/73.0 mg/kg bw/day):</b> ↓ bw; ↑ incidence of mineralized particles in colloid of isolated thyroid follicles, ↓ bwg (♀).<br><br><b>1800 ppm (103/144 mg/kg bw/day):</b> ↓ thyroid colloid aggregation, ↓ incidence of renal nephropathy, ↓ urine protein; ↑ retinal atrophy, ↑ porphyrin accumulation in Harderian glands (♀).<br><br>No effect on TSH, T3 or T4.<br><br><b>Not oncogenic.</b> |

| Study Type/ Animal/<br>PMRA#                                                | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| 2-year dietary<br><br>B6C3F1 mouse<br><br>PMRA# 1155697,<br>1155705         | NOAEL = 1000 ppm (208/272 mg/kg bw/day; ♂/♀)<br><br>≥1000 ppm (208/274 mg/kg bw/day): non-adverse findings - sporadic ↓ fc; ↓ bwg (♂); ↓ water intake (♀).<br><br>2000 ppm (414/424 mg/kg bw/day): ↑ incidence of squeaking and twittering, ↓ bw after week 13, ↓ bwg, water consumption, ↓ fc (♂); ↓ food conversion efficiency, ↓ liver and spleen wt (♀).<br><br>Not oncogenic.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>REPRODUCTION AND DEVELOPMENTAL TOXICITY</b>                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Multi-generation dietary<br><br>Wistar rat<br><br>PMRA# 1155687,<br>1155688 | <u><b>Parental</b></u><br>NOAEL = 250 ppm (16.5/18.9 mg/kg bw/day; ♂/♀)<br><br>700 ppm (47.3/ 52.3 mg/kg bw/day): ↓ bwg during premating (F <sub>0</sub> ), ↑ demethylase activity; ↓ bwg (F <sub>1</sub> ♀) during premating, 1 <sup>st</sup> gestation, and 2 <sup>nd</sup> gestation; ↑ bwg during lactation (F <sub>1A/B</sub> , F <sub>2A/B</sub> ); ↑ cytochrome P450 content (♂); ↓ fc (♀).<br><br><u><b>Reproductive</b></u><br>NOAEL > 700 ppm (47.3/52.3 mg/kg bw/day)<br>LOAEL not established.<br>No treatment-related findings.<br><br><u><b>Offspring</b></u><br>NOAEL = 250 ppm (18.9 mg/kg bw/day)<br><br>700 ppm (52.3 mg/kg bw/day): ↓ pup wt during lactation (F <sub>1A/B</sub> , F <sub>2A/B</sub> ).<br><br>Note: study report dated 1990 - limited organ weights (liver, ovaries, testes), no sperm assessment, no ovarian follicle counts. |
| Developmental toxicity<br><br>Sprague Dawley rat<br><br>PMRA# 1155698       | <u><b>Maternal</b></u><br>NOAEL = 10 mg/kg bw/day<br><br>30 mg/kg bw/day: ↓ bwg GD 6-11 and 6-16, ↓ corrected bwg GD 6-21, ↓ fc GD 6-11.<br><br>100 mg/kg bw/day: ↓ bwg, ↓ corrected bwg GD 6-21, ↓ fc during treatment, ↑ fc post-dosing.<br><br><u><b>Developmental</b></u><br>NOAEL = 30 mg/kg bw/day<br><br>100 mg/kg bw/day: slight ↑ in incidence of wavy ribs.<br><br>No evidence of sensitivity of the young.                                                                                                                                                                                                                                                                                                                                                                                                                                              |



| Study Type/ Animal/<br>PMRA#                                                            | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| Developmental toxicity -<br>Range-finding<br><br>Chinchilla rabbit<br><br>PMRA# 2428119 | Supplemental. NOAEL not established.<br><br><u>Maternal</u><br>≥50 mg/kg bw/day: ↓ bw and fc.<br><br>100 mg/kg bw/day: ↑ post-implantation loss, markedly ↓ number of live fetuses per dam<br><br><u>Developmental</u><br>≥50 mg/kg bw/day: ↓ fetal wt.<br><br>100 mg/kg bw/day: markedly ↓ number of live fetuses per dam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Developmental toxicity<br><br>Chinchilla rabbit<br><br>PMRA# 1155699                    | <u>Maternal</u><br>NOAEL = 8 mg/kg bw/day<br><br>24 mg/kg bw/day: transient ↓ bwg and fc during dosing.<br><br>72 mg/kg bw/day: 2 unscheduled deaths (GD 18, 19), 1 abortion (GD 26), 2 total litter resorptions, ↓ bw GD 17-21, ↓ bwg, body weight loss during dosing, ↓ fc during treatment and post-dosing, ↑ late resorptions, ↓ postimplantation loss, ↑ number of live fetuses/litter.<br><br><u>Developmental</u><br>NOAEL = 24 mg/kg bw/day<br><br>72 mg/kg bw/day: 1 abortion (GD 26), 2 total litter resorptions, ↑ late resorptions, ↑ postimplantation loss, ↓ number of live fetuses/litter, ↓ litter weights, ↓ fetal wt (more pronounced in &), slight ↑ in skeletal malformations (fused, asymmetric, missing and abnormally ossified sternebrae, shortened tail) - total of 5/83 fetuses (3/11 litters) versus 0/136 (0/16) in controls.<br><br><b>Evidence of malformations at maternally-toxic dose.</b> |
| <b>NEUROTOXICITY</b>                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Acute neurotoxicity<br><br>Sprague Dawley rat<br><br>PMRA# 1039613,<br>1039650          | NOAEL (♂) = 42 mg/kg bw; NOAEL (♀) not established<br><br>≥42 mg/kg bw: ↓ motor and locomotor activity days 0, 7 and 14 (♀).<br><br>≥151 mg/kg bw: tremors; red nasal staining, ↓ motor and locomotor activity day 0 (♂).<br><br>307 mg/kg bw: mortalities day 0-1, clinical signs days 0-1 (tremors, uncoordinated gait, ↓ activity, coolness to touch, nasal staining), findings noted days 0-5 included: ↓ number of rears, ↓ grip strength (forelimb and hindlimb), ↓ response to stimuli (auditory, touch, tail pinch), ↑ gait abnormalities, ↑ righting reflex impairments, and ↓ body temperature; ↓ motor and locomotor activity days 7 and 14, ↓ absolute brain wt (♂)<br><br>No neuropathology findings.<br><br>20 mg/kg bw (♀; supplemental study): ↓ motor and locomotor activity days 0, 7 and 14 (♀).                                                                                                         |

| Study Type/ Animal/<br>PMRA#                                                                                                                          | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| 13-week neurotoxicity<br><br>Fischer rat<br><br>PMRA# 1039643,<br>1039652, 259324                                                                     | NOAEL = 150 ppm (9.3/10.5 mg/kg bw/day; ♂/♀)<br><br>≥1000 ppm (63.3/ 69.3 mg/kg bw/day): ↓ bwg (first 4 weeks), ↓ terminal bw; ↓ forelimb grip strength (♂).<br><br>No neuropathology findings.                                                                                                                                                                                                                                                                                                                                                                                   |
| Developmental<br>neurotoxicity (2001)<br><br>Wistar rat<br><br>PMRA# 591475                                                                           | <u>Maternal</u><br>NOAEL = 20 mg/kg bw/day<br><br>750 ppm (55 mg/kg bw/day): ↓ bwg LD 0-7, ↓ fc week 3 of gestation and week 1 of lactation.<br><br><u>Offspring</u><br>NOAEL = 20 mg/kg bw/day<br><br>750 ppm (55 mg/kg bw/day): ↓ bw before weaning and after weaning with recovery (♀) by PND 50; ↓ bwg during lactation with recovery by PND 17; ↓ overall locomotor activity on PND 17 and 21 (♀); ↑ in errors and time to complete trial 1 in session 1 of water maze testing at study termination (♂); ↓ thickness of caudate/putamen (♀; only assessed at the high-dose). |
| <b>GENOTOXICITY</b>                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Gene mutations in<br>bacteria<br><br>Salmonella typhimurium<br>strains TA 98, TA 100,<br>TA 1535 and TA 1537;<br>E. Coli WP2uvrA<br><br>PMRA# 1155714 | Negative up to 5000 µg/plate with and without activation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Gene mutations in<br>bacteria<br><br>Salmonella typhimurium<br>strains TA 98, TA 100,<br>TA 1535 and TA 1537<br><br>PMRA# 1155710                     | Negative up to 12,500 µg/plate with and without activation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Gene mutations in<br>mammalian cells in vitro<br><br>Chinese hamster ovary<br>cells (HGPRT locus)<br><br>PMRA# 1155706                                | Negative up to 125 µg/mL without activation and 1222 µg/mL with activation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Study Type/ Animal/<br>PMRA#                                                                     | Study Results                                                                                    |
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| Chromosome aberration<br>in vivo<br><br>Chinese hamster<br><br>PMRA# 1155701                     | <b>Negative</b>                                                                                  |
| Chromosome aberration<br>in vivo<br><br>NMRI mice (%)<br><br>PMRA# 1155700                       | <b>Negative</b><br>2/10 died at 100 mg/kg bw in a pilot study.                                   |
| Chromosome aberrations<br>in vitro<br><br>Human lymphocyte cells<br><br>PMRA# 1155711            | <b>Positive</b> at 500 µg/mL without activation and 1300 µg/mL with activation, both toxic doses |
| Micronucleus assay in<br>vivo<br><br>Bor:NMRI (SPF Han)<br>mouse<br><br>PMRA# 1155755            | <b>Negative</b><br>2/ 10 died in a pilot study at 100 mg/kg bw.                                  |
| Sister chromatid<br>exchange in vivo<br><br>Chinese hamster<br><br>PMRA# 1155693,<br>1155694     | <b>Negative</b>                                                                                  |
| Sister chromatid<br>exchange in vitro<br><br>Chinese hamster ovary<br>cells<br><br>PMRA# 1155756 | <b>Negative</b> up to 400 µg/mL without activation and 1250 µg/mL with activation                |
| Sister chromatid<br>exchange in vitro<br><br>Chinese hamster ovary<br>cells<br><br>PMRA# 1155756 | <b>Positive</b> at 500 µg/mL without activation (toxic dose) and 2000 µg/mL with activation      |

| Study Type/ Animal/<br>PMRA#                                                                                                                                                                                                                | Study Results                                                                               |
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| Mitotic recombination<br><br>Saccharomyces cerevisiae strain D7<br><br>PMRA# 1155718                                                                                                                                                        | <b>Negative</b> for crossing-over in yeast up to 10,000 µg/mL with and without activation   |
| DNA repair<br><br>Bacillus subtilis strains H17 (Rec+) and H45 (Rec-)<br><br>PMRA# 1155717                                                                                                                                                  | <b>Negative</b> up to 5000 µg/plate with and without activation                             |
| Unscheduled DNA synthesis in vitro<br><br>Primary rat hepatocytes (% Fischer 344 rat)<br><br>PMRA# 1155754                                                                                                                                  | <b>Negative</b> up to 750 µg/mL, a toxic dose                                               |
| <b>GENOTOXICITY- Technical Imidacloprid (AMP-W process) containing two impurities, in other words, N-[(6-chloro-3-pyridinyl)methyl] -1,2-ethanediamine (PEDA) and N, N'-bis-[6-chloro-3-pyridinyl] methyl] -1,2-ethanediamine (DIPEDA).</b> |                                                                                             |
| Gene mutations in bacteria<br><br>Salmonella typhimurium strains TA 98, TA 100, TA 1535 and TA 1537<br><br>PMRA# 1181354, 1181365                                                                                                           | <b>Negative</b> up to 5000 µg/plate.                                                        |
| <b>GENOTOXICITY – Desnitro-imidacloprid (metabolite)</b>                                                                                                                                                                                    |                                                                                             |
| Reverse mutation assay<br><br>Salmonella typhimurium strains TA98, TA100, TA1535 and TA1537 and E. coli strain WP2uvrA<br><br>PMRA# 2030941                                                                                                 | <b>Negative</b> up to 12500 µg/plate with activation and 2500 µg/ plate without activation. |



| Study Type/ Animal/<br>PMRA#                                                                                                                | Study Results                                                     |
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| <b>GENOTOXICITY – Urea metabolite (mammalian metabolite)</b>                                                                                |                                                                   |
| Reverse mutation assay<br><br>Salmonella typhimurium strains TA98, TA100, TA1535 and TA1537 and E. coli strain WP2uvrA<br><br>PMRA# 2030942 | <b>Negative</b> up to 5000 µg/plate with and without activation   |
| <b>GENOTOXICITY – Olefin-imidacloprid (mammalian metabolite)</b>                                                                            |                                                                   |
| Reverse mutation assay<br><br>Salmonella typhimurium strains TA98, TA100, TA1535 and TA1537 and E. coli strain WP2uvrA<br><br>PMRA# 2030943 | <b>Negative</b> up to 5000 µg/ plate with and without activation. |
| <b>GENOTOXICITY – Nitrosimine-imidacloprid (mammalian metabolite)</b>                                                                       |                                                                   |
| Gene mutations in bacteria<br><br>Salmonella typhimurium strains TA 98, TA 100, TA 1535 and TA 1537; E. Coli WP2uvrA<br><br>PMRA# 1155715   | <b>Negative</b> up to 5000 µg/plate with and without activation   |
| Gene mutations in mammalian cells in vitro<br><br>Chinese hamster V79 cells (HGPRT locus)<br><br>PMRA# 1155707                              | <b>Negative</b> up to 2000 µg/mL with and without activation      |

| Study Type/ Animal/<br>PMRA#                                                                                              | Study Results                                                                                |
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| Gene mutations in<br>mammalian cells in<br>vitro<br><br>Chinese hamster ovary<br>cells (HGPRT locus)<br><br>PMRA# 1155702 | <b>Negative</b> up to 2000 µg/mL with and without activation                                 |
| Micronucleus assay (in<br>vivo)<br><br>BDF1 mouse (%)<br><br>Pilot study<br><br>PMRA# 1155753                             | <b>Negative</b> up to 80 mg/kg bw.<br>2/5 died at 100 mg/kg bw in preliminary testing        |
| Micronucleus assay (in<br>vivo)<br><br>BDF1 mouse (%)<br><br>Pilot study<br><br>PMRA# 1155751                             | <b>Negative</b> up to 160 mg/kg bw.<br>1/5 died at 200 mg/kg bw in preliminary testing.      |
| Micronucleus assay (in<br>vivo)<br><br>Bor:NMRI (SPF Han)<br>mouse<br><br>PMRA# 1155709                                   | <b>Negative</b> up to 50 mg/kg bw.<br>100% lethality at 100 mg/kg bw in preliminary testing. |
| Micronucleus assay (in<br>vivo)<br><br>Bor:NMRI (SPF Han)<br>mouse<br><br>PMRA# 1155708                                   | <b>Negative</b> up to 100 mg/kg bw.<br>1/10 died at 100 mg/kg bw in preliminary testing.     |
| Chromosome aberrations<br>in vitro<br><br>Chinese hamster V79<br>cells<br><br>PMRA# 1155703                               | <b>Negative</b> up to 1000 µg/mL with and without activation                                 |

| Study Type/ Animal/<br>PMRA#                                                                                                                                      | Study Results                                                                                                                                                                                                                                                                                                                                                                       |
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| Chromosome aberrations<br>in vitro<br><br>Chinese hamster ovary<br>cells<br><br>PMRA# 1155738                                                                     | Negative up to 1000 µg/mL with and without activation                                                                                                                                                                                                                                                                                                                               |
| Unscheduled DNA<br>synthesis in vitro<br><br>Primary rat hepatocytes<br>(%)<br>Wistar CF HB rats)<br><br>PMRA# 1155713                                            | Negative up to 1333 µg/mL                                                                                                                                                                                                                                                                                                                                                           |
| <b>SPECIAL STUDIES</b>                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                     |
| Estrogen receptor<br>binding assay<br><br>Uterine cytosol from<br>ovariectomized ♀<br>Sprague Dawley rat<br><br>PMRA# 2182451                                     | Negative for competitive binding with the estrogen receptor at $10^{-10}$ to $10^{-3}$ M.                                                                                                                                                                                                                                                                                           |
| Androgen receptor<br>binding assay<br><br>Prostate cytosol from<br>castrated ♂ Sprague<br>Dawley rat<br><br>PMRA# 2182447                                         | Negative for competitive binding with the androgen receptor at $10^{-10}$ to $10^{-3}$ M.                                                                                                                                                                                                                                                                                           |
| Estrogen receptor<br>transcriptional activation<br>assay<br><br>Stably transfected hERα-<br>HeLa-9903 cells (human<br>cervical cancer cells)<br><br>PMRA# 2182445 | Negative for estrogen receptor transcriptional activation at $10^{-10}$ to $10^{-4}$ M.                                                                                                                                                                                                                                                                                             |
| Steroidogenesis assay<br><br>H295R cells (human<br>adrenocortical carcinoma<br>cells)<br><br>PMRA# 2182448                                                        | Negative for interference with steroidogenesis at $10^{-10}$ to $10^{-4}$ M.<br><br>No inhibition or induction of testosterone or estradiol.<br><br>Limitations in study conduct and reporting: no assessment of accuracy or precision of hormone measurement system was performed; cell viability detection method differed from guideline; cell viability data were not provided. |

| Study Type/ Animal/<br>PMRA#                                                                           | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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| Aromatase assay<br><br>Human recombinant<br>aromatase (CYP 19)<br>microsomes<br><br>PMRA# 2182449      | Negative for the inhibition of aromatase activity at $10^{-10}$ to $10^{-3}$ M.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Uterotrophic assay<br>(gavage)<br><br>Intact immature ♀<br>Sprague Dawley rat<br><br>PMRA# 2182450     | Negative for estrogenic activity.<br><br>No effect on uterine wt.<br><br><b>100 mg/kg bw/day:</b> ↓bw/bwg, piloerection with hunched posture.<br><br>No assessment of anti-estrogenic effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Hershberger assay<br>(gavage)<br><br>Castrated ♂ Sprague<br>Dawley rat<br><br>PMRA# 2182452            | Negative for both androgenic and anti-androgenic activity.<br><br><b>80 mg/kg bw/day:</b> ↓ bw/bwg.<br><br>No effect on the wts of five androgen-dependent tissues in castrated rats.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>NON-GUIDELINE AND/OR SUPPLEMENTAL PUBLICATIONS</b>                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Disposition and acute<br>toxicity (gavage)<br><br>Wistar rat (♀)<br><br>PMRA# 2409253                  | Supplemental<br><br><b>20 mg/kg bw:</b> Salivation, diarrhea, piloerection and dyspnea at 6, 12, 24 and 48 hrs, tremors at 6 and 12 hrs, ↑SGOT, SGPT, bilirubin, BUN, BChE, EChE.<br>Peak concentrations of imidacloprid and metabolites 6-chloronicotinic acid (6-CNA) and 6-hydroxynicotinic acid (6-HNA) were seen at 12 hours in brain, blood, liver, kidney, ovary and urine. $C_{max}$ for imidacloprid was in the order of urine > blood > brain > feces > liver > kidney > ovary. $C_{max}$ for 6-CNA was urine > kidney > blood > feces > brain > liver > ovary. $C_{max}$ for 6-HNA was urine > blood > feces > kidney > liver > ovary > brain (♀) |
| Acute in utero toxicity<br>on GD9<br>(intraperitoneal)<br><br>Sprague Dawley rat<br><br>PMRA# 2418091  | Supplemental<br><br><b>337 mg/kg bw(in utero):</b> PND 30 offspring demonstrated ↓sensorimotor performance, ↑AChE in cortex, ↑ligand binding for muscarinic acetylcholine receptor (m2mAChR), ↑GFAP immunostaining in sections of motor cortex and of hippocampus (no effect on ligand binding for nicotinic acetylcholine receptor $\alpha 4\beta 2$ nAChR); ↑AChE in midbrain (♂); ↑AChR in brainstem (♀)                                                                                                                                                                                                                                                  |
| Acute oxidant and<br>inflammatory activity<br>(intravenous)<br><br>Wistar rat (♀)<br><br>PMRA# 2417845 | Supplemental<br><br><b>26 mg/kg bw:</b> 2 hours post-dose ↑nitric oxide in brain, liver and plasma, ↑MDA in liver and plasma, ↑oxidant enzymes (xanthine oxidase and myeloperoxidase) in brain and liver, ↑SOD in liver, ↑glutathione peroxidase in brain, ↓glutathione peroxidase in liver, ↓glutathione in brain and liver, up-regulation of inflammatory markers TNF- $\alpha$ , IL-6 and IL-1 $\beta$ mRNA transcripts in brain and liver, down-regulation of anti-inflammatory cytokine IL-10 mRNA transcript in brain and liver, up-regulation of iNOS mRNA in liver, down-regulation of iNOS and nNOS mRNA in brain                                   |



| Study Type/ Animal/<br>PMRA#                                                             | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| Acute oral toxicity<br>(gavage)<br><br>Swiss albino mouse<br><br>PMRA# 2417844           | Supplemental<br><br><b>15 mg/kg bw:</b> ↑MDA, ↓GSH, ↑CAT, ↑SOD, ↑GPx, ↑GST in liver samples obtained 24h post dose.<br><br>Co-treatment with 200 mg/kg bw vitamin C ameliorated all the above mentioned effects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 28 day oral toxicity<br>study (gavage)<br><br>Sprague Dawley rat(♂)<br><br>PMRA# 2418125 | Supplemental<br><br><b>80 mg/kg bw/day:</b> ↓total protein (Day 14/28), ↑ALT, ↑AST (Day 14/28), ↓GSH, dilation and congestion of central hepatic vein (Day 14), moderate congestion, dilation of sinusoids and vacuolation of cytoplasm of hepatocytes/fatty change, severe congestion of the portal vein and degeneration of hepatocytes (Day 28), swollen hepatocyte nuclei, sinusoidal congestion, disrupted chromatin, varied size and shape of mitochondria and disrupted RER (Day 28)<br><br>Co-treatment with 10 mg/kg bw vitamin C ameliorated the abovementioned effects.                                                                                                                                                                                                                                                                                                                                                                                 |
| 60-day toxicity study<br>(gavage)<br><br>Wistar rat (♀)<br><br>PMRA# 2409273             | Supplemental; Confidor end-use product 17.2%<br><br><b>≥ 10 mg/kg bw/day:</b> diarrhea, ↓PChE, ↓BChE, mild inflammatory infiltration and moderate congestion of sinusoids of liver. (♀)<br><br><b>20 mg/kg bw/day:</b> ↑salivation, sluggish movement, tremors, fatigue, ↓fc, disturbed estrous cyclicity (↑diestrous, ↓estrous), ↓relative heart and spleen wt, ↑acid phosphatase, marked dilation and congestion of central vein and degeneration of hepatocytes. (♀)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 13-week oral toxicity<br>(gavage)<br><br>Wistar rat (♀)<br><br>PMRA# 2418109,<br>2418111 | Non-guideline<br><br>NOAEL for liver toxicity = 10 mg/kg bw/day<br><br><b>≥ 5 mg/kg bw/day:</b> ↓ BChE<br><br><b>10 mg/kg bw/day:</b> ↓ PChE activity, locomotor activity effects (↓ ambulatory time).<br><br><b>20 mg/kg bw/day:</b> clinical signs (diarrhea, salivation, dyspnea, piloerection), ↓ bw, ↓ fc, ↑rel liver & kidney wts, ↑ biochemical parameters (SGOT, GPT, glucose, BUN), locomotor activity effects (↓distance travelled, ↓ambulatory time, ↓stereotypic time, ↑resting time), histopathological changes in the brain (necrosed Purkinje cells with loss of dendrites and granules in cerebellum), liver effects (mild focal necrosis with swollen cellular nuclei) and kidney effects (slight degeneration of tubules and glomeruli), ↓ rel ovary wt, ↑FSH, ↓LH, ↓progesterone, ↑lipid peroxidation in liver, kidney and ovary, oxidative stress assessments in liver, brain and ovary indicated ↓catalase, ↓SOD, ↓glutathione, ↓glutathione. |
| Micronucleus assay in<br>vitro<br><br>Human lymphocyte cells<br><br>PMRA# 2418099        | <b>Negative</b> up to 100 µg/mL without activation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Sister chromatid<br>exchange in vitro<br><br>Human lymphocyte cells<br><br>PMRA# 2418099 | <b>Negative</b> up to 100 µg/mL, without activation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Study Type/ Animal/<br>PMRA#                                                                                                       | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Micronucleus assay in vivo<br><br>Wistar rat<br><br>PMRA# 2418099                                                                  | <b>Negative</b> up to 200 mg/kg bw<br><b>Positive</b> at 300 mg/kg bw                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| nAChR toxicity<br>Cerebellar cultures from neonatal rats<br><br>PMRA# 2409279                                                      | Supplemental<br><br><b>1-100 <math>\mu</math>M:</b> intracellular excitatory $Ca^{2+}$ influxes in cerebellar neurons which are mainly composed of granule cells. Calcium influx was inhibited by 3 nAChR antagonists suggesting imidacloprid has direct agonist activity at nAChR in cerebellar neurons; no effect on large-sized Purkinje cells on GFAP-positive astrocytes.                                                                                                                                 |
| nAChR toxicity in stellate cells of mouse cochlear nucleus<br><br>PMRA# 2418096                                                    | Supplemental<br><br><b><math>\geq 10 \mu</math>M:</b> exposure for <1 minute changed membrane properties of the neurons tested. Co-exposure with nAChR antagonists d-tubocurarine or $\alpha$ -bungarotoxin blocked the reaction suggesting the involvement of nicotinic receptors                                                                                                                                                                                                                             |
| nAChR toxicity in mouse fibroblast M10 cells stably transfected with $\alpha 4\beta 2$ AChR<br><br>PMRA# 2418127, 2418129          | Supplemental<br><br>Cells exposed to imidacloprid, desnitro-imidacloprid or nicotine for 3 days showed $\uparrow$ [3H]-nicotine binding 5-8-fold (up-regulation of $\alpha 4\beta 2$ AChR). Imidacloprid showed a low affinity and low potency to $\alpha 4\beta 2$ AChR relative to nicotine but affinity and potency of desnitro-imidacloprid was comparable to nicotine. LD <sub>50</sub> s in mice (i.p.) were 45, 8 and 0.08 mg/kg bw for imidacloprid, desnitro-imidacloprid and nicotine, respectively. |
| nAChR toxicity in mouse neuroblast N1E-115 cells stably transfected with $\alpha 4\beta 2$ AChR<br><br>PMRA# 2418131               | Supplemental<br><br>Desnitro-imidacloprid activates the extracellular signal-regulated kinase (ERK) cascade via interaction with neuronal $\alpha 4\beta 2$ and intracellular $Ca^{2+}$ in this cell population at 1 $\mu$ M (similar to nicotine). Imidacloprid activation occurred at 100 $\mu$ M.                                                                                                                                                                                                           |
| nAChR binding in mouse brain<br><br>Swiss Webster mouse<br><br>PMRA# 2417850                                                       | Supplemental<br><br>50% inhibition of [3H]-nicotine binding with imidacloprid (12 nM), desnitro metabolite of imidacloprid (15 nM) and olefin-imidacloprid (83 nM). Corresponding intraperitoneal LD <sub>50</sub> s were 7-15, 16-24 and >50 mg/kg bw respectively. Nicotine binding 24-79-fold greater in housefly with imidacloprid and olefin-imidacloprid; nicotine binding greater in mouse than housefly with desnitro metabolite.                                                                      |
| nAChE toxicity Human neuroblastoma cells, SH-SY5Y Torpedo electric organ<br><br>PMRA# 2418127                                      | Supplemental<br><br>Alpha-containing nAChRs in Torpedo cells and $\alpha 3$ - and $\alpha 7$ - containing nAChR from human neuroblastoma cells were 2-4 fold more sensitive to desnitro-imidacloprid than to nicotine. Imidacloprid showed low affinity for the $\alpha 1$ , $\alpha 3$ and $\alpha 7$ nAChR subtypes.                                                                                                                                                                                         |
| nAChE toxicity Human embryonic kidney (HEK 293) cell line stably expressing human $\alpha 4\beta 2$ receptors<br><br>PMRA# 2418114 | Supplemental<br><br>Weak activation of receptors with 300 $\mu$ M imidacloprid compared to 1mM acetylcholine in patch-clamp assay. Imidacloprid acted as a competitive antagonist when co-applied with acetylcholine.                                                                                                                                                                                                                                                                                          |

| Study Type/ Animal/<br>PMRA#                                                                                          | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <p>Case Reports of Intentional Imidacloprid Poisonings (Suicides)</p> <p>PMRA# 2417847, 2417846, 2417844, 2418123</p> | <p>Supplemental</p> <p><u>Case 1: 69-year old female with possible pre-existing coronary arterial disease; 200 ml Confidor (9.6% a.i.)</u><br/>Clinical signs included drowsiness, vomiting and diaphoresis 30 min after ingestion. Blood pressure was 170/73 mm Hg, temperature 35°C, respiration rate 24 breaths/min. Lesions in oropharynx. Tachycardia noted. Chest x-ray normal. Cardiac enzymes (including creatine kinase, creatine kinase MB isoform and troponin-I) considered normal. Cholinesterase inhibition tests were negative. Signs of severe cardiac toxicity including ventricular fibrillation were evident. Patient ultimately succumbed 12 hours after hospitalization to hypotension and arrhythmias.</p> <p><u>Case 2: 35-year old male; 350 ml imidacloprid (unknown purity)</u><br/>Clinical signs included nausea, copious vomiting, disorientation, drowsiness, dizziness and heart palpitations 1 hour after ingestion. Pulse rate 130 bpm, blood pressure 165/95 mm Hg, mydriasis and apnea were evident. Hypokalemia, hypernatremia and elevated white blood cell count were observed. Cholinesterase activity was normal. Cardiopulmonary arrest occurred on the first day of admission and on day 6 of admission. Patient did not respond to advanced life support and died on day 6.</p> <p><u>Case 3: 67-year old male with possible pre-existing cardiovascular disease; Unknown volume; (18.2% a.i.)</u><br/>Clinical signs included drowsiness and irritability. Blood pressure of 117/56 mm Hg, respiratory rate of 16 breaths/min. ECG was normal for sinus rhythm; left hypertrophy was indicated by voltage. Chest x-ray indicated cardiomegaly with right lower lung infiltration. Cardiac enzymes (including creatine kinase and troponin) were minimally increased while creatine kinase-MB was normal. Tachycardia, persistent high fever, anuria, and metabolic acidosis with partial compensation were observed. Cholinesterase inhibition test results were negative. 3 hours after admission, cyanosis, ventricular arrhythmia and cardiac arrest occurred. Patient was discharged against medical advice and died 3 days later.</p> <p><u>Case 4: 33-year old male, found dead. 66-year old male, found dead</u><br/>At post-mortem, imidacloprid concentration in blood samples was 12.5 and 2.05 µg/ml and in liver samples was 9.9 and 1.01 µg/ml, respectively</p> <p>Additional observations noted in 66 year old male included chemical burns in the mouth and esophagus and pulmonary edema. Possible indications of chronic cardiac insufficiency.</p> |
| <p>Multiple case reports of Intentional Imidacloprid Poisonings (Suicides)</p> <p>PMRA# 2418115</p>                   | <p>Unspecified formulations containing 20% a.i.</p> <p>Mild symptoms noted in 54/56 cases included nausea, vomiting, headache, dizziness, abdominal pain and diarrhea; 2 required intensive medical management for respiratory failure or prolonged sedation. Exposure was confirmed in 28 with median admission plasma concentrations of 10.56 ng/L (range 0.02-51.25 ng/L). Median time to present to hospital was 4 hours post-ingestion. Median volume reported ingested was 15 mL (unknown in 23 cases). In 7 of the 8 cases with serial blood samples, imidacloprid remained elevated for 10-15 hrs post-ingestion.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

**Table 2 Toxicology Endpoints for Use in Health Risk Assessment for Imidacloprid**

| <b>Exposure Scenario</b>                                 | <b>Dose (mg/kg bw/day)</b>     | <b>Study</b>                       | <b>Endpoint</b>                                                                                | <b>CAF or Target MOE<sup>1</sup></b> |
|----------------------------------------------------------|--------------------------------|------------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------|
| Acute dietary                                            | NOAEL = 8                      | 90-day dietary study in the dog    | Clinical signs (trembling) during the first week of dosing and slight emaciation               | 100                                  |
|                                                          | <b>ARfD = 0.08 mg/kg bw</b>    |                                    |                                                                                                |                                      |
| Chronic Dietary                                          | NOAEL = 5.7                    | 2-year dietary study in the rat    | ↑ incidence of mineralized particles in the colloid of isolated follicles in the thyroid gland | 100                                  |
|                                                          | <b>ADI = 0.06 mg/kg bw/day</b> |                                    |                                                                                                |                                      |
| Short-term dermal and incidental oral                    | NOAEL = 8                      | 90-day dietary study in the dog    | Clinical signs (trembling) during the first week of dosing and slight emaciation               | 100                                  |
| Short-term inhalation                                    | NOAEL = 8.4                    | 28-day inhalation study in the rat | Liver, clinical chemistry and haematology changes                                              | 100                                  |
| Intermediate-term dermal, inhalation and incidental oral | NOAEL = 8                      | 90-day dietary study in the dog    | Clinical signs (trembling) during the first week of dosing and slight emaciation               | 100                                  |
| Long-term dermal and inhalation                          | NOAEL = 5.7                    | 2-year dietary study in the rat    | ↑ incidence of mineralized particles in the colloid of isolated follicles in the thyroid gland | 100                                  |
| Aggregate short- and intermediate-term (all routes)      | NOAEL = 8                      | 90-day dietary study in the dog    | Clinical signs (trembling) during the first week of dosing and slight emaciation               | 100                                  |

<sup>1</sup> CAF (composite assessment factor) refers to a total of uncertainty and PCPA factors for dietary assessments; MOE refers to a target MOE for occupational and residential assessments.





## Appendix IV Dietary Exposure and Risk Estimates for Imidacloprid

**Table 1 Summary of Acute Dietary Exposure and Risk from Imidacloprid**

| Subpopulations             | Acute Dietary (95 <sup>th</sup> percentile) <sup>1</sup> |       |                     |       |
|----------------------------|----------------------------------------------------------|-------|---------------------|-------|
|                            | Food only                                                |       | Food + Water        |       |
|                            | Exposure (mg/kg bw)                                      | %ARfD | Exposure (mg/kg bw) | %ARfD |
| General Population (total) | 0.016253                                                 | 20    | 0.017936            | 22    |
| All Infants (< 1 year old) | 0.029900                                                 | 37    | 0.032854            | 41    |
| Children 1-2 years old     | 0.040925                                                 | 51    | 0.043310            | 54    |
| Children 3-5 years old     | 0.033662                                                 | 42    | 0.035524            | 44    |
| Children 6-12 years old    | 0.018929                                                 | 24    | 0.020301            | 25    |
| Youth 13-19 years old      | 0.010612                                                 | 13    | 0.011666            | 15    |
| Adults 20-49 years old     | 0.011471                                                 | 14    | 0.013229            | 17    |
| Adults 50+ years old       | 0.011876                                                 | 15    | 0.013275            | 17    |
| Females 13-49 years old    | 0.011494                                                 | 14    | 0.013239            | 17    |

<sup>1</sup> Acute Reference Dose (ARfD) of 0.08 mg/kg bw.

**Table 2 Summary of Chronic Dietary Exposure and Risk from Imidacloprid**

| Subpopulations             | Chronic Dietary <sup>1</sup> |      |                         |      |
|----------------------------|------------------------------|------|-------------------------|------|
|                            | Food only                    |      | Food + Water            |      |
|                            | Exposure (mg/kg bw/day)      | %ADI | Exposure (mg/kg bw/day) | %ADI |
| General Population (total) | 0.002955                     | 5    | 0.003117                | 6    |
| All Infants (< 1 year old) | 0.005703                     | 10   | 0.006120                | 11   |
| Children 1-2 years old     | 0.009775                     | 17   | 0.010008                | 18   |
| Children 3-5 years old     | 0.007126                     | 13   | 0.007323                | 13   |
| Children 6-12 years old    | 0.003966                     | 7    | 0.004108                | 7    |
| Youth 13-19 years old      | 0.002181                     | 4    | 0.002299                | 4    |
| Adults 20-49 years old     | 0.002326                     | 4    | 0.002487                | 4    |
| Adults 50+ years old       | 0.002434                     | 4    | 0.002594                | 5    |
| Females 13-49 years old    | 0.002215                     | 4    | 0.002376                | 4    |

<sup>1</sup> Acceptable Daily Intake (ADI) of 0.06 mg/kg/day



## Appendix V Food Residue Chemistry Summary

Imidacloprid is a neonicotinoid insecticide that is readily taken up by and translocated systemically within the plants. It is active against insects on contact and through ingestion.

The nature of the residue in livestock and plant commodities is adequately understood based on acceptable metabolism studies in lactating goats, hens, potatoes, apples, tomatoes, cotton seed, eggplant and corn. The residue definition for imidacloprid in all food commodities is currently expressed in Canada as (2E)-1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine, including metabolites containing the 6-chloropyridinyl moiety.

Analytical methods for both plant and animal matrices are common moiety methods that rely on the conversion of imidacloprid and its metabolites into 6-chloronicotinic acid for quantification. They have been validated by independent laboratories and therefore are considered adequate as enforcement methods. Additionally, a multi-residue analytical method is listed in the US FDA's Pesticide Analytical Manual Volume II for imidacloprid.

Available field trial data for registered crops support the established MRLs, and therefore are deemed adequate.

Overall, no major data gaps were identified. Therefore, no residue chemistry data are required as a result of imidacloprid re-evaluation.

The *Food and Drugs Act* prohibits the sale of adulterated food; that is, food containing a pesticide residue that exceeds the specified maximum residue limit (MRL). Pesticide MRLs are specified for *Food and Drugs Act* purposes through the evaluation of scientific data under the *Pest Control Products Act (PCPA)*. An MRL represents the maximum amount of residues that may remain on food when a pesticide is used according to label directions, and serves as a food safety standard. The Canadian Food Inspection Agency is responsible for monitoring the Canadian food supply for pesticide residues and the determination of compliance with MRLs specified by Health Canada.

MRLs for imidacloprid are currently specified for a wide range of commodities. Residues in all other agricultural commodities, including those approved for treatment in Canada but without a specific MRL, are regulated under Subsection B.15.002(1) of the *Food and Drugs Regulations*, which requires that residues do not exceed 0.1 ppm. A complete list of MRLs specified in Canada can be found on the PMRA's MRL Database, an online query application that allows users to search for specified MRLs, regulated under the *Pest Control Products Act*, both for pesticides or food commodities (<http://pr-rp.hc-sc.gc.ca/mrl-lrm/index-eng.php>).





## Appendix VI Agricultural Mixer/Loader/Applicator and Postapplication Risk Assessment

**Table 1 Commercial Mixer/Loader/Applicator Exposure and Risk Assessment for Foliar and Soil Applications**

| Equipment <sup>a</sup>         | Formulation | ATPD <sup>b</sup> | Rate<br>(g a.i./ha) <sup>c</sup> | MOE                 |                         |                       |
|--------------------------------|-------------|-------------------|----------------------------------|---------------------|-------------------------|-----------------------|
|                                |             |                   |                                  | Dermal <sup>d</sup> | Inhalation <sup>d</sup> | Combined <sup>e</sup> |
| Airblast                       | Liquid      | 20 ha             | 112                              | 1500                | 27000                   | 1400                  |
| Aerial – (mixer/loader)        | Liquid      | 400 ha            | 49                               | 13000               | 20000                   | 7900                  |
| Aerial - (Applicator)          | Liquid      | 400 ha            | 49                               | 68000               | 466000                  | 59000                 |
| Custom Groundboom <sup>f</sup> | Liquid      | 360 ha            | 480                              | 1400                | 2300                    | 890                   |
| MPHW                           | WP          | 150 L             | 36900                            | 6500                | 3100                    | 2100                  |
| MPHG                           | WP (WSP)    | 3800 L            | 281.25                           | 1100                | 2000                    | 700                   |
| Backpack                       | WP          | 150 L             | 36900                            | 600                 | 2800                    | 500                   |
| Chemigation (mixer/loader)     | WP          | 140 ha            | 355.2                            | 480                 | 230                     | 160                   |
| Low Pressure Turf Sprayer      | WP (WSP)    | 150L              | 281.25                           | 120000              | 50000                   | 35000                 |
| Tractor Drawn Spreader         | Granule     | 16 ha             | 280                              | 6000                | 9000                    | 3600                  |
| Push Rotary Spreader           | Granule     | 2 ha              | 280                              | 48000               | 69000                   | 28400                 |
| Belly Grinder                  | Granule     | 0.4 ha            | 280                              | 4000                | 72000                   | 4200                  |

ATPD = area treated per day, MPHW = manually pressurized handwand, MPHG = mechanically pressurized handgun, WP = wettable powder, WSP = water soluble packaging

<sup>a</sup> The highest mixer/loader/application exposure and risk scenarios for each application equipment is presented.

<sup>b</sup> Default ATPD value. For handheld equipment, the default values for amount handled per day (L/ha) were converted to areas using the minimum spray label volume.

<sup>c</sup> Maximum label application rate.

<sup>d</sup> Exposure (mg/kg bw/day) = Rate \* ATPD \* 0.001 (g to kg) \* Unit Exposure (µg/kg ai) /body weight (80 kg for adults). MOE = NOAEL/Exposure. NOAEL is based on the oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100. A 5% dermal absorption factor was applied to the exposure estimates.

<sup>e</sup> Combined MOE = 1/(1/dermal MOE + 1/inhalation MOE).

<sup>f</sup> The custom applicator groundboom scenario addresses exposure to both large and small acreage groundboom applicators.

**Table 2 Mixer/Loader Tree Injection Exposure and Risk Assessment**

| Equipment      | Formulation | ATPD<br>(trees) | Rate<br>(g a.i./ cm<br>dbh) | Amount Handled<br>(kg a.i./day) <sup>a</sup> | MOE                 |                         |                       |
|----------------|-------------|-----------------|-----------------------------|----------------------------------------------|---------------------|-------------------------|-----------------------|
|                |             |                 |                             |                                              | Dermal <sup>b</sup> | Inhalation <sup>b</sup> | Combined <sup>c</sup> |
| Tree Injection | Liquid      | 200             | 0.257                       | 5.14                                         | 49000               | 80000                   | 30000                 |

dbh = diameter at breast height.

<sup>a</sup> Highest rate was used. Amount handled = rate × 100 cm (max dbh) × 200 (max trees treated per day) × 0.001 (g to kg conversion).

<sup>b</sup> Exposure (mg/kg bw/day) = Amount handled \* Unit Exposure ( µg/kg ai) /body weight (80 kg for adults). MOE = NOAEL/Exposure. NOAEL is based on short-intermediate-term oral NOAEL of 8 mg/kg bw/day. Target MOE = 100. A 5% dermal absorption factor was applied to the dermal MOE and exposure estimates.

<sup>c</sup> Combined MOE = 1/(1/dermal MOE + 1/inhalation MOE).

Table 3 Seed and Potato Seed Piece Treatment Exposure and Risk Assessment

| Crop <sup>a</sup>                                                                                                              | Formulation <sup>b</sup>      | Activity <sup>c</sup>                  | Seed Treated <sup>d</sup><br>(kg seed/day) | Rate <sup>e</sup><br>(g a.i./kg seed) | MOE <sup>f</sup> |            |                       |
|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------------|--------------------------------------------|---------------------------------------|------------------|------------|-----------------------|
|                                                                                                                                |                               |                                        |                                            |                                       | Dermal           | Inhalation | Combined <sup>g</sup> |
| Commercial Seed Treatment                                                                                                      |                               |                                        |                                            |                                       |                  |            |                       |
| PMRA#1676911 (2006). Long-sleeved shirt, pants, chemical-resistant gloves, Open mix/load, MLA Exposure only.                   |                               |                                        |                                            |                                       |                  |            |                       |
| Lentil, Chickpea, Bean                                                                                                         | Liquid                        | MLA                                    | 73000                                      | 0.625                                 | 1060             | 5680       | 890                   |
| Pea                                                                                                                            | Liquid                        | MLA                                    | 73000                                      | 1.25                                  | 530              | 2840       | 450                   |
| Wheat, Barley, Oats                                                                                                            | Liquid                        | MLA                                    | 92000                                      | 0.3                                   | 1750             | 9390       | 1480                  |
| Soybean                                                                                                                        | Liquid                        | MLA                                    | 63000                                      | 1.25                                  | 610              | 3290       | 510                   |
| Corn                                                                                                                           | Liquid                        | MLA                                    | 60000                                      | 4.8                                   | 170              | 900        | 140                   |
| PMRA #2074087 (2010). Coveralls, long-sleeved shirt, pants, chemical-resistant gloves, Closed Mix/Load. MLA, Bagger, Cleaners. |                               |                                        |                                            |                                       |                  |            |                       |
| Lentil, Chickpea, Bean                                                                                                         | Liquid                        | Cleaner                                | -                                          | 0.625                                 | 3600             | 810        | 660                   |
| Pea, Soybean                                                                                                                   | Liquid                        | Cleaner                                | -                                          | 1.25                                  | 1820             | 400        | 330                   |
| Wheat, Barley, Oats                                                                                                            | Liquid                        | Cleaner                                | -                                          | 0.3                                   | 7600             | 1680       | 1380                  |
| Corn                                                                                                                           | Liquid                        | Cleaner                                | -                                          | 4.8                                   | 210              | 55         | 44                    |
|                                                                                                                                |                               | Cleaner with Respirator <sup>h,i</sup> | -                                          | 4.8                                   | 210              | 550        | 150                   |
| Canola, Mustard                                                                                                                | Liquid, WP (WSP) <sup>h</sup> | MLA                                    | 67000                                      | 8.02                                  | 450              | 1060       | 310                   |
|                                                                                                                                |                               | Bagger/Sewer/Stacker                   | 67000                                      | 8.02                                  | 3250             | 790        | 640                   |
|                                                                                                                                |                               | Cleaner                                | -                                          | 8.02                                  | 280              | 63         | 51                    |
|                                                                                                                                |                               | Cleaner with Respirator <sup>h,i</sup> | -                                          | 8.02                                  | 280              | 630        | 200                   |
| On Farm Seed Treatment                                                                                                         |                               |                                        |                                            |                                       |                  |            |                       |
| PMRA #106150 (1999). Long-sleeved shirt, pants, chemical-resistant gloves, Open mix/load, Open Cab Planter.                    |                               |                                        |                                            |                                       |                  |            |                       |
| Wheat, Barley, Oats                                                                                                            | Liquid                        | All tasks (Load/Treat/Plant)           | 60000                                      | 0.3                                   | 1700             | 160        | 150                   |
| Corn                                                                                                                           | Liquid                        | All tasks (Load/Treat/Plant)           | 1350                                       | 4.8                                   | 4800             | 440        | 410                   |
| Bean, Pea, Chickpea, Soybean                                                                                                   | Liquid                        | All tasks (Load/Treat/Plant)           | 10000                                      | 1.25                                  | 2500             | 230        | 210                   |
| Canola, Mustard                                                                                                                | Liquid                        | All tasks (Load/Treat/Plant)           | 600                                        | 8.02                                  | 6500             | 600        | 550                   |

| Crop <sup>a</sup>                                                           | Formulation <sup>b</sup> | Activity <sup>c</sup>            | Seed Treated <sup>d</sup><br>(kg seed/day) | Rate <sup>e</sup><br>(g a.i./kg seed) | MOE <sup>f</sup> |            |                       |
|-----------------------------------------------------------------------------|--------------------------|----------------------------------|--------------------------------------------|---------------------------------------|------------------|------------|-----------------------|
|                                                                             |                          |                                  |                                            |                                       | Dermal           | Inhalation | Combined <sup>g</sup> |
| Potato Seed Piece Treatment                                                 |                          |                                  |                                            |                                       |                  |            |                       |
| PMRA #1484699 (2006). Long-sleeved shirt, pants, chemical-resistant gloves. |                          |                                  |                                            |                                       |                  |            |                       |
| Potato Seed Pieces                                                          | Liquid                   | Treater                          | 290400                                     | 0.094                                 | 1600             | 2100       | 900                   |
|                                                                             |                          | Cutter/Sorter                    | 290400                                     | 0.094                                 | NM               | 1300       | NM                    |
|                                                                             |                          | Treater/Cutter/Sorter            | 290400                                     | 0.094                                 | 1600             | 1300       | 720                   |
| PMRA #157367 (2001). Long-sleeved shirt, pants, chemical-resistant gloves.  |                          |                                  |                                            |                                       |                  |            |                       |
| Potato Seed Pieces                                                          | Dust                     | All positions including planting | 178000                                     | 0.094                                 | 270              | 490        | 170                   |

MLA = Mixer/Loader/Applicator, MOE = Margin of Exposure, NM = Not Monitored

Bold MOEs indicate MOE estimates that are less than the target MOE of 100.

<sup>a</sup> Some Crops were grouped together based on similarities in their use pattern, application rate, and seed type. Throughput data for one crop in the group was as a surrogate data for other crops in the group due to limitations in the throughput database.

<sup>b</sup> Liquid formulation includes suspensions.

<sup>c</sup> Activities monitored in the exposure study.

<sup>d</sup> Standard commercial throughput data was used for canola, soybean, and wheat. Refined estimates were used for bean, chickpea, lentil, and corn. Surrogate throughput data for canola was used for mustard and surrogate throughput data for wheat was used for barley and oats. Potato seed piece throughput based on survey data. Farm throughput are upper bound estimates for amount of seeds planted per day based on PMRA survey data.

<sup>e</sup> Maximum application rates were used in the risk assessment.

<sup>f</sup> Exposure (mg/kg bw/day) = Amount handled \* Unit Exposure (µg/kg a.i. or g a.i./100 kg seed for cleaners)/body weight (80 kg for adults). MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100. A 5% dermal absorption factor was applied to the dermal exposure estimates. Amount handled = seed treated/day \* rate \* 0.001 (g to kg) for MLA and bagger/sewer/stacker. For cleaners, amount handled = rate/100 kg seed.

<sup>g</sup> Combined MOE = 1/(1/dermal MOE + 1/inhalation MOE).

<sup>h</sup> There are no commercial seed treatment studies available for WP formulations. Exposure data from liquid formulations used in the studies would be similar to wettable powder in water soluble packaging (WSP), as such WSP is required to assess commercial seed treatment exposure for WP.

<sup>i</sup> The cleaner exposure data for corn was based on cleaners wearing a single layer and chemical-resistant gloves and no coveralls.

<sup>j</sup> A 90% protection factor (PF) was applied to inhalation exposure and risk estimates for MLA and cleaners wearing respirators.



**Table 4 Commercial Postapplication Dermal Exposure and Risk Assessment for Foliar Applications**

| Crop                                                   | Activity <sup>a</sup>  | Rate <sup>b</sup><br>(g a.i./ha) | # of<br>App. | App.<br>Interval | TC<br>(cm <sup>2</sup> /hr) | DFR <sup>c</sup><br>(µg/cm <sup>2</sup> ) | Exposure <sup>d</sup><br>(mg/kg<br>bw/day) | MOE <sup>e</sup> |
|--------------------------------------------------------|------------------------|----------------------------------|--------------|------------------|-----------------------------|-------------------------------------------|--------------------------------------------|------------------|
| Christmas Trees                                        | Irrigation (hand set)  | 60                               | 2            | 7                | 1750                        | 0.222                                     | 0.00194                                    | 4100             |
| Soybean                                                | Scouting               | 49                               | 2            | 5                | 1100                        | 0.195                                     | 0.00107                                    | 7500             |
| Potato, Tomato                                         | Irrigation (hand set)  | 49                               | 2            | 5                | 1750                        | 0.195                                     | 0.00170                                    | 4700             |
| Carrot, Leafy Vegetables, Eggplant,<br>Parsley, Peanut | Irrigation (hand set)  | 48                               | 2            | 5                | 1750                        | 0.191                                     | 0.00167                                    | 4800             |
| Globe artichoke, Pea (dry), Tobacco                    | Irrigation (hand set)  | 48                               | 2            | 7                | 1750                        | 0.177                                     | 0.00155                                    | 5200             |
| Broccoli <sup>f</sup>                                  | Hand Harvesting        | 49                               | 2            | 5                | 5150                        | 0.195                                     | 0.00502                                    | 1600             |
| Apple                                                  | Thinning               | 91.2                             | 2            | 10               | 3000                        | 0.308                                     | 0.00461                                    | 1700             |
| Peach                                                  | Thinning               | 55.2                             | 2            | 7                | 3000                        | 0.204                                     | 0.00306                                    | 2600             |
| Cherry                                                 | Thinning               | 55.2                             | 2            | 10               | 3000                        | 0.186                                     | 0.00279                                    | 2900             |
| Blackberry                                             | Irrigation (hand set)  | 42                               | 2            | 7                | 1750                        | 0.155                                     | 0.00136                                    | 5900             |
| Blueberry (high and low bush)                          | Irrigation (hand set)  | 42                               | 2            | 5                | 1750                        | 0.167                                     | 0.00146                                    | 5500             |
| Raspberry                                              | Irrigation (hand set)  | 112                              | 2            | 7                | 1750                        | 0.413                                     | 0.00362                                    | 2200             |
| Blueberry (high bush)                                  | Irrigation (hand set)  | 84                               | 1            | -                | 1750                        | 0.147                                     | 0.01423                                    | 560              |
| Grape                                                  | Girdling/Turning       | 48                               | 2            | 14               | 19300                       | 0.210                                     | 0.00184                                    | 4350             |
| Strawberry                                             | Hand Harvesting        | 42                               | 1            | -                | 1100                        | 0.105                                     | 0.00058                                    | 13850            |
| Almond                                                 | Scouting               | 55.2                             | 2            | 6                | 580                         | 0.211                                     | 0.00061                                    | 13000            |
| Hops                                                   | Harvesting, mechanical | 55.2                             | 1            | -                | 19300                       | 0.138                                     | 0.01332                                    | 600              |
| Turf (Sod)                                             | Transplanting/Plant    | 281.25                           | 1            | -                | 6700                        | 0.281                                     | 0.00942                                    | 850              |
| Turf (Golf)                                            | Transplanting/Plant    | 280                              | 1            | -                | 6700                        | 0.281                                     | 0.00942                                    | 850              |

TC = Transfer Coefficient, DFR = Dislodgeable Foliar Residue, TTR = Turf Transferable Residue, N/A = Not Applicable, App. = Application

<sup>a</sup> Activity with the highest TC for each crop was included in this table.

<sup>b</sup> Maximum application rate for each representative crop was included in this table.

<sup>c</sup> The default peak DFR value of 25% of the application rate was assumed and a dissipation rate of 10%/day was assumed for 2 application scenarios. The default peak TTR value of 1% was assumed. For 2 application scenarios, DFR = Rate \* 25% \* App. Interval \* 10%/day + Rate \* 25%.

<sup>d</sup> Dermal exposure on Day 0 after application = TC \* DFR \* 8 hours/day \* Dermal Absorption (5%) / Body Weight (80 kg).

<sup>e</sup> MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100

<sup>f</sup> Minimum application interval of 5 days was used for broccoli, it is the representative crop for crop group 5 (minimum application interval of 7 days) and crop group 5A (minimum application interval of 5 days).

**Table 5 Commercial Postapplication Dermal Exposure and Risk Assessment for Soil Treatments**

| Crop                                                              | Max Rate (g a.i./ha) | Concentration in soil <sup>a</sup> (µg a.i./g soil) | Dermal Exposure <sup>b,c,d,e</sup> (µg/kg bw/day) | Dermal MOE <sup>f</sup> |
|-------------------------------------------------------------------|----------------------|-----------------------------------------------------|---------------------------------------------------|-------------------------|
| GH cucumber                                                       | 142.3                | 0.95                                                | 0.00039                                           | 14000000                |
| GH Pepper (mature plants)                                         | 225.35               | 1.51                                                | 0.0006                                            | 9200000                 |
| GH Tomato, GH Eggplant                                            | 355.5                | 2.38                                                | 0.001                                             | 5800000                 |
| GH Ornamentals (container plants)                                 | 1112                 | 7.45                                                | 0.0031                                            | 1850000                 |
| GH CG 5A Head and stem Brassica, GH Pepper (transplant seedlings) | 32299.8              | 216.41                                              | 0.09                                              | 64000                   |
| GH Lettuce (transplant seedlings)                                 | 36900                | 247.23                                              | 0.102                                             | 56000                   |

GH= greenhouse, MOE = Margins of Exposure, CG = crop groups, RAGS = Risk Assessment Guidance for Superfund

<sup>a</sup> Concentration of imidacloprid in soil. Calculated with the formula  $C_{\text{soil}} (\mu\text{g a.i./g soil}) = \text{Rate } (\mu\text{g/cm}^2) \times \text{Fraction available in soil (per cm)} \times 0.67 \text{ conversion factor (cm}^3 \text{ to g)}$ . Assumption of fraction a.i.available in upper 1 cm of soil of 1 from USEPA Risk Assessment Guidance for Superfund.

<sup>b</sup> Events per day based on the USEPA RAGS recommendation of a single event per day for risk assessment purposes. Based on the assumption that after a period of work and exposure to soil, a "threshold" soil loading is achieved. Thus, to approximate the typical workday for postapplication exposure, 1 event per day was assumed.

<sup>c</sup> Dermal exposure (µg/kg bw/day) = Concentration of imidacloprid in soil (µg a.i./g soil) \* Adherence factor (mg/cm<sup>2</sup> - event) \* Soil conversion factor mg to g soil (1x10<sup>-3</sup>) \* Dermal absorption of imidacloprid in soil (0.05) \* Surface area (cm<sup>2</sup>) \* 1 event/day /body weight (80 kg for adults).

<sup>d</sup> Dermal exposure calculation assumes an adherence factor of 0.2 and a surface area of 3300 cm<sup>2</sup> according to the RAGS guidance document.

<sup>e</sup> The dermal absorption factor (0.05) was used as the dermal absorption of imidacloprid in soil. It is most likely a conservative assumption, as there is typically higher absorption when contacted as a liquid formulation.

<sup>f</sup> MOE = NOAEL/Exposure. The NOAEL is based on oral NOAEL of 5.7 mg/kg bw/day for long-term scenarios. Target MOE = 100.

**Table 6 Commercially Treated and Bagged Seed Planting Exposure and Risk Assessment<sup>a</sup>**

| Crop <sup>b</sup>                                                                             | Formulation | Application Rate <sup>c</sup> (g a.i./kg seed) | Planting Rate <sup>d</sup> (kg seed/ha) | Area Planted Per Day <sup>e</sup> (ha) | MOE                              |                                      | Combined MOE |
|-----------------------------------------------------------------------------------------------|-------------|------------------------------------------------|-----------------------------------------|----------------------------------------|----------------------------------|--------------------------------------|--------------|
|                                                                                               |             |                                                |                                         |                                        | Dermal <sup>f</sup> Target = 100 | Inhalation <sup>g</sup> Target = 100 |              |
| PMRA 1571553 (2007). Baseline <sup>h</sup> PPE, Open loading, Closed cab planter <sup>i</sup> |             |                                                |                                         |                                        |                                  |                                      |              |
| Corn                                                                                          | Liquid      | 4.8                                            | 28.9                                    | 100                                    | 610                              | 560                                  | 290          |
| PMRA 2313627 (2013). Baseline <sup>h</sup> PPE, Open loading, Closed cab planter <sup>i</sup> |             |                                                |                                         |                                        |                                  |                                      |              |
| Cereals (except corn)                                                                         | Liquid      | 0.3                                            | 174.9                                   | 162                                    | 1300                             | 210                                  | 180          |
| Oilseed <sup>j</sup>                                                                          |             | 8.02                                           | 11.2                                    | 100                                    | 1200                             | 200                                  | 170          |
| Legumes                                                                                       |             | 1.25                                           | 126                                     | 100                                    | 700                              | 110                                  | 100          |

|           |             |       |      |                |       |      |      |
|-----------|-------------|-------|------|----------------|-------|------|------|
| Carrot    | Import Only | 20.7  | 5.6  | 32             | 3000  | 480  | 410  |
| Leek      |             | 11.2  | 4.5  | 32             | 6800  | 1100 | 950  |
| Onion     |             | 11.2  | 16.9 | 32             | 1800  | 290  | 250  |
| Lettuce   |             | 140   | 4.5  | 1 <sup>k</sup> | 17000 | 2800 | 2400 |
| Broccoli  |             | 105   | 2.2  | 32             | 1500  | 240  | 200  |
| Cabbage   |             | 105   | 4.5  | 32             | 730   | 120  | 100  |
| Tomato    |             | 4.41  | 2.3  | 32             | 34000 | 5500 | 4700 |
| Pepper    |             | 12.45 | 3.4  | 32             | 8100  | 1300 | 1100 |
| Cucurbits |             | 10    | 6.8  | 32             | 5000  | 820  | 700  |

MOE = Margin of Exposure

<sup>a</sup> Planting on-farm treated seed was covered in the on-farm exposure studies. Planting commercial bulk seed is considered to be evaluated by on-farm treating and planting of seed as there is no additional exposure from loading seed from in bulk format.

<sup>b</sup> Crops treated with imidacloprid using seed treatment were assembled into four groups, cereals, corn, oilseeds and legumes in order to compensate for missing data specific to each crop within these groups. Crops were grouped by similarities in their use pattern, application rate, seed planted per day and seed type. The crop with the maximum values for area planted and seeding rate were selected for the Tier 1 risk assessment to represent the group. In addition to the four groups of seeds in this assessment, imported treated seeds (treated outside of Canada) were assessed for exposure during planting activities only and listed individually.

<sup>c</sup> Maximum application rates were used in the risk assessment.

<sup>d</sup> Maximum planting rate were used in the risk assessment, kg seed/ ha values were selected over kg seed/ day as it is more representative of the scenario. Rates were taken from use information and PMRA survey data.

<sup>e</sup> Unless otherwise specified, maximum area planted per day values were used in the risk assessment from PMRA survey data.

<sup>f</sup> Where dermal MOE = NOAEL/Exposure, based on the oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios and dermal absorption of 5%. Exposure (mg/kg bw/day) = Unit exposure (µg/kg ai) × Application Rate (kg a.i./kg seed) × Dermal Absorption (5%) × Seeding Rate (kg seed/ha) × Area Planted (ha/day)/bw (kg)

<sup>g</sup> Where inhalation MOE = inhalation NOAEL/Exposure, based on the short-to intermediate term inhalation NOAEL of 8 mg/kg bw/day. Exposure (mg/kg bw/day) = Unit exposure (µg/kg ai) × Application Rate (kg a.i./kg seed) × Seeding Rate (kg seed/ha) × Area Planted (ha/day)/bw (kg)

<sup>h</sup> Baseline PPE is comprised of a long-sleeved shirt, long pants, and chemical-resistant gloves.

<sup>i</sup> As the study was conducted with a closed cab planter, the risk assessment only accounts for exposure with closed cab planting.

<sup>j</sup> Both liquid and wettable powder formulation crops are included in the table as a liquid, due to similar anticipated exposure while planting seed treated with both formulations.

<sup>k</sup> 90<sup>th</sup> percentile values from Statistics Canada 2011 Census of Canadian Farm Size were used for refinement.

## Appendix VII Non-Occupational Risk Assessment

**Table 1 Residential Applicator Exposure and Risk for Pet Use and Turf**

| Scenario                             | Rate <sup>a</sup>    | ATPD <sup>a,b</sup> | Dermal                        |                                         |                   | Inhalation                    |                                         |                  | Combined MOE <sup>c</sup> |
|--------------------------------------|----------------------|---------------------|-------------------------------|-----------------------------------------|-------------------|-------------------------------|-----------------------------------------|------------------|---------------------------|
|                                      |                      |                     | UE <sup>b</sup><br>(mg/kg ai) | Exposure <sup>c</sup><br>(mg/kg bw/day) | MOE <sup>d</sup>  | UE <sup>b</sup><br>(mg/kg ai) | Exposure <sup>c</sup><br>(mg/kg bw/day) | MOE <sup>d</sup> |                           |
| Pets - Spot On <sup>f</sup>          | $5.6 \times 10^{-7}$ | 2                   | 264.55                        | $1.9 \times 10^{-7}$                    | $4.3 \times 10^7$ | Negligible                    |                                         |                  | -                         |
| TG - Push Type Rotatory <sup>g</sup> | $2.8 \times 10^{-5}$ | 2000                | 1.79                          | 0.0001                                  | 127694            | 0.0057                        | 0.000004                                | 2000000          | 120000                    |
| TG - Belly Grinder <sup>g</sup>      | $2.8 \times 10^{-5}$ | 93                  | 793.66                        | 0.0013                                  | 6193              | 0.086                         | 0.000003                                | 2900000          | 6200                      |
| TG - Hand Dispersal <sup>g</sup>     | $2.8 \times 10^{-5}$ | 9.3                 | 352.74                        | 0.0001                                  | 139352            | 0.84                          | 0.000003                                | 2900000          | 130000                    |

ATPD = Area treated per day, UE = unit exposure, MOE = Margin of Exposure, TG = Turf Granule

<sup>a</sup> Rate units are kg a.i./pet for pet and kg a.i./m<sup>2</sup> for turf use. The ATPD units are pets/day for pet treatment and m<sup>2</sup>/day for turf treatment.

<sup>b</sup> Values provided by USEPA Residential SOPs 2012. Assumed PPE for residential applicators is shorts, short sleeved shirt, shoes and socks.

<sup>c</sup> Exposure (mg/day) = UE × Application Rate × ATPD × Dermal Absorption (5%)/Body weight (80 kg for adults)

<sup>d</sup> Dermal or Inhalation MOE = NOAEL/Exposure. NOAEL based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100.

<sup>e</sup> Combined MOE = 1/((1/MOE dermal)+(1/MOE inhalation))

<sup>f</sup> The maximum application rate of 0.56 mg a.i. for spot-on treatment of extra-large dogs was used.

<sup>g</sup> Three other application methods were included in the Residential SOPs 2012: spoon, cup and shaker can. The three methods with the highest unit exposure values were included in this assessment, as the spoon, cup and shaker can are expected to be of lesser exposure to the user than push-type rotary spreader, belly grinder and hand dispersal.

**Table 2 Residential Postapplication Dermal Exposure and Risk from Turf Use**

| Life Stage | Formulation <sup>a</sup> | Scenario | TTR<br>(µg/cm <sup>2</sup> ) <sup>b</sup> | TC <sup>c</sup><br>(cm <sup>2</sup> /hr) | Exposure Time <sup>c</sup><br>(hr) | Dermal Exposure (mg/kg<br>bw/day) <sup>d</sup> | Dermal MOE <sup>e</sup> |
|------------|--------------------------|----------|-------------------------------------------|------------------------------------------|------------------------------------|------------------------------------------------|-------------------------|
| Adult      | Liquid                   | HCLA     | 0.3                                       | 180000                                   | 1.5                                | 0.0047                                         | 1700                    |
|            |                          | Mowing   | 0.3                                       | 5500                                     | 1                                  | 0.0001                                         | 83000                   |
|            |                          | Golfing  | 0.3                                       | 5300                                     | 4                                  | 0.0004                                         | 21000                   |
|            | Granule                  | HCLA     | 0.1                                       | 200000                                   | 1.5                                | 0.0011                                         | 7600                    |
|            |                          | Mowing   | 0.3                                       | 5500                                     | 1                                  | 0.0001                                         | 83000                   |
|            |                          | Golfing  | 0.3                                       | 5300                                     | 4                                  | 0.0004                                         | 21000                   |



| Life Stage            | Formulation <sup>a</sup> | Scenario | TTR<br>( $\mu\text{g}/\text{cm}^2$ ) <sup>b</sup> | TC <sup>c</sup><br>( $\text{cm}^2/\text{hr}$ ) | Exposure Time <sup>c</sup><br>(hr) | Dermal Exposure (mg/kg<br>bw/day) <sup>d</sup> | Dermal MOE <sup>e</sup> |
|-----------------------|--------------------------|----------|---------------------------------------------------|------------------------------------------------|------------------------------------|------------------------------------------------|-------------------------|
| Youth 11 to < 16 yr   | Liquid                   | HCLA     | 0.3                                               | 148000                                         | 1.3                                | 0.0047                                         | 1700                    |
|                       |                          | Mowing   | 0.3                                               | 4500                                           | 1                                  | 0.0001                                         | 72000                   |
|                       |                          | Golfing  | 0.3                                               | 4400                                           | 4                                  | 0.0004                                         | 18000                   |
|                       | Granule                  | HCLA     | 0.1                                               | 164000                                         | 1.3                                | 0.0011                                         | 7600                    |
|                       |                          | Mowing   | 0.3                                               | 4500                                           | 1                                  | 0.0001                                         | 72000                   |
|                       |                          | Golfing  | 0.3                                               | 4400                                           | 4                                  | 0.0004                                         | 18000                   |
| Children 6 to < 11 yr | Liquid                   | Golfing  | 0.3                                               | 2900                                           | 4                                  | 0.0005                                         | 16000                   |
|                       | Granule                  | Golfing  | 0.3                                               | 2900                                           | 4                                  | 0.0005                                         | 16000                   |
| Children 1 to < 2 yr  | Liquid                   | HCLA     | 0.3                                               | 49000                                          | 1.5                                | 0.0094                                         | 850                     |
|                       | Granule                  | HCLA     | 0.1                                               | 54000                                          | 1.5                                | 0.0021                                         | 3900                    |

TTR = Turf Transferable Residue, TC = Transfer Coefficient, MOE = Margin of Exposure, HCLA = High Contact Lawn Activities

<sup>a</sup> Liquid formulation refers to registered turf treatment in wettable powder form (in water soluble bags).

<sup>b</sup> TTR on day 0 (0 days after application) using maximum application rate. Where TTR = Application Rate (kg a.i./m<sup>2</sup>, using an application rate of 0.0000281 kg a.i./m<sup>2</sup> for the liquid, 0.000028 kg a.i./m<sup>2</sup> for granules)  $\times$  Fraction of transferable a.i. (0.01 for liquids and 0.002 for granules)  $\times$  [(1 - Fraction of residue that dissipates per day (0.1) <sup>0</sup> day after application (0 days))]  $\times$  Weight unit conversion factor  $\mu\text{g}/\text{kg}$  ( $1 \times 10^9$ )  $\times$  Area unit conversion factor  $\text{m}^2/\text{cm}^2$  (0.0001). Calculations followed the USEPA Residential SOPs 2012.

<sup>c</sup> Default values from USEPA Residential SOPs 2012.

<sup>d</sup> Exposure (mg/kg bw/day) = [TTR on day 0 ( $\mu\text{g}/\text{cm}^2$ )  $\times$  Conversion Factor 0.001 (mg/ $\mu\text{g}$ )  $\times$  TC ( $\text{cm}^2/\text{hr}$ )  $\times$  Exposure Time (hrs/day)  $\times$  Dermal Absorption (5%)]/Body Weight. Body weight for adults 80 kg, youth 57 kg, children 6 to < 11 years 32 kg, and children 1 to < 2 years 11 kg.

<sup>e</sup> Dermal MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100.

**Table 3 Residential Postapplication Dermal Exposure and Risk from Treated Pets**

| Animal Type | Animal Size        | Lifestage             | SA of pet <sup>a</sup><br>( $\text{cm}^2/\text{animal}$ ) | Rate <sup>b</sup><br>(mg ai) | Transferable Residue <sup>c</sup><br>( $\mu\text{g}/\text{cm}^2$ ) | Dermal Exposure <sup>d</sup><br>(mg/kg bw/day) | Dermal MOE <sup>e</sup> |
|-------------|--------------------|-----------------------|-----------------------------------------------------------|------------------------------|--------------------------------------------------------------------|------------------------------------------------|-------------------------|
| Dog         | Small <sup>f</sup> | Adult                 | 1989                                                      | 0.06                         | $5.6 \times 10^{-7}$                                               | $1.4 \times 10^{-6}$                           | 5700000                 |
|             |                    | Youth (11 < 16 years) | 1989                                                      | 0.06                         | $5.6 \times 10^{-7}$                                               | $2.0 \times 10^{-6}$                           | 4100000                 |
|             |                    | Child (1 < 2 yrs)     | 1989                                                      | 0.06                         | $5.6 \times 10^{-7}$                                               | $3.6 \times 10^{-6}$                           | 2200000                 |
|             | Medium             | Adult                 | 2914                                                      | 0.14                         | $9.6 \times 10^{-7}$                                               | $2.4 \times 10^{-6}$                           | 3300000                 |
|             |                    | Youth (11 < 16 years) | 2914                                                      | 0.14                         | $9.6 \times 10^{-7}$                                               | $3.3 \times 10^{-6}$                           | 2400000                 |
|             |                    | Child (1 < 2 yrs)     | 2914                                                      | 0.14                         | $9.6 \times 10^{-7}$                                               | $6.1 \times 10^{-6}$                           | 1300000                 |
|             | Large              | Adult                 | 5210                                                      | 0.35                         | $1.4 \times 10^{-6}$                                               | $3.4 \times 10^{-6}$                           | 2400000                 |
|             |                    | Youth (11 < 16 years) | 5210                                                      | 0.35                         | $1.4 \times 10^{-6}$                                               | $4.7 \times 10^{-6}$                           | 1700000                 |
|             |                    | Child (1 < 2 yrs)     | 5210                                                      | 0.35                         | $1.4 \times 10^{-6}$                                               | $8.6 \times 10^{-6}$                           | 940000                  |
|             | Extra Large        | Adult                 | 8883                                                      | 0.56                         | $1.3 \times 10^{-6}$                                               | $3.2 \times 10^{-6}$                           | 2500000                 |

|     |                     |                      |      |      |                      |                      |         |
|-----|---------------------|----------------------|------|------|----------------------|----------------------|---------|
| Cat | Small <sup>g</sup>  | Youth (11 <16 years) | 8883 | 0.56 | $1.3 \times 10^{-6}$ | $4.4 \times 10^{-6}$ | 1800000 |
|     |                     | Child (1 <2 yrs)     | 8883 | 0.56 | $1.3 \times 10^{-6}$ | $8.0 \times 10^{-6}$ | 1000000 |
|     |                     | Adult                | 1500 | 0.06 | $7.5 \times 10^{-7}$ | $1.9 \times 10^{-6}$ | 4300000 |
|     |                     | Youth (11 <16 years) | 1500 | 0.06 | $7.5 \times 10^{-7}$ | $2.6 \times 10^{-6}$ | 3100000 |
|     |                     | Child (1 <2 yrs)     | 1500 | 0.06 | $7.5 \times 10^{-7}$ | $4.8 \times 10^{-6}$ | 1700000 |
|     |                     | Adult                | 2500 | 0.11 | $9.0 \times 10^{-7}$ | $2.2 \times 10^{-6}$ | 3600000 |
|     | Medium <sup>g</sup> | Youth (11 <16 years) | 2500 | 0.11 | $9.0 \times 10^{-7}$ | $3.1 \times 10^{-6}$ | 2600000 |
|     |                     |                      |      |      |                      |                      |         |

MOE = Margin of Exposure, SA = Surface Area

<sup>a</sup> Smallest weight on the product label was used to determine the SA for each dog size group. The resulting SAs were used in the risk assessment; small dog = 1989 cm<sup>2</sup>, medium dog = 2914 cm<sup>2</sup>, large dog = 5210 cm<sup>2</sup>, extra-large dog = 8883 cm<sup>2</sup>. For cats, the SA default value from the USEPA Residential SOPs (USEPA, 2012) were used in the assessment: small cat = 1500 cm<sup>2</sup>, medium cat = 2500 cm<sup>2</sup>.

<sup>b</sup> Rate (mg ai) = Container Size (L) × Imidacloprid Density (g/L) × Conversion Factor (1000 mg/g) × % a.i. in product. Imidacloprid Density = 1.54 g/L, maximum label % a.i. = 9.10%.

<sup>c</sup> Transferable Residue (mg/cm<sup>2</sup>) = (Application Rate (mg ai) × Fraction of the application rate available as transferable residue) / Surface Area of pet (cm<sup>2</sup>/animal)

<sup>d</sup> Exposure (mg/day) = Transferable Residue (µg/cm<sup>2</sup>) × Transfer Coefficient (cm<sup>2</sup>/hr) × Exposure Time (hrs/day) × Conversion Factor 0.001 (µg/mg) × Dermal Absorption (5%)/Body Weight (kg). Body weight for adults 80 kg, youth, 57 kg, and children 11 kg. Calculated according to the USEPA Residential SOPs 2012.

<sup>e</sup> Dermal MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100.

<sup>f</sup> For small dogs, only a maximum weight was indicated on the label, therefore an estimate of the smallest weight was used, small dog = 2.5 kg.

<sup>g</sup> Spot-on treatment labels for cats did not specify weights for "small" and "medium" cats. Therefore, this risk assessment assumes the smallest weight group, less than 4 kg, to be "small" cats, and over 4 kg, to be "medium" sized cats.

**Table 4 Residential Postapplication Surface-to-Hand-to-Mouth Incidental Oral Exposure and Risk from Turf Use**

| Lifestage <sup>a</sup> | Formulation         | Hand Residue <sup>b</sup> (mg/cm <sup>2</sup> ) | Oral Exposure <sup>c</sup> (mg/kg bw/day) | Incidental Oral MOE <sup>d</sup> |
|------------------------|---------------------|-------------------------------------------------|-------------------------------------------|----------------------------------|
| Children 1 to <2 year  | Liquid <sup>e</sup> | 0.00041                                         | 0.0038                                    | 2100                             |
|                        | Granules            | 0.00004                                         | 0.0004                                    | 21000                            |

MOE = Margin of Exposure

<sup>a</sup> Children 1 to <2 years has been chosen as the index lifestage to assess based on their behavioral characteristics (likelihood of putting hand in mouth following potential dermal imidacloprid exposure) and the strengths and limitations of the available data.

<sup>b</sup> Hand residue loading (mg/cm<sup>2</sup>) = Fraction a.i. on hands compared to total surface residue (0.15) × Exposure (mg/day, using an application rate of 0.0000281 kg a.i./m<sup>2</sup> for the liquid formulation, 0.000028 kg a.i./m<sup>2</sup> for granules)/Typical Surface Area of one hand (cm<sup>2</sup>) × 2

<sup>c</sup> Exposure (mg/day) = Hand Residue Loading (mg/cm<sup>2</sup>) × Fraction Hand Surface Area Mouthed/event (0.13/event) × Typical Surface Area of one hand (150 cm<sup>2</sup>) × Exposure Time (Carpet: 4 hrs/day, Hard Surfaces: 2 hrs/day) × Number of replenishment intervals per hour (4 intervals/hour) × [1-(1-Saliva Extraction Factor, 0.48)^(Number of hand-to-mouth contact events per hour (20 events/hour)/Number of replenishment intervals per hour (4 intervals/hour))]/ body weight (11 kg for children 1 to <2 year). Calculated according to the USEPA Residential SOPs 2012.

<sup>d</sup> Incidental Oral MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100.

<sup>e</sup> Liquid formulation refers to registered turf treatment in wettable powder form (in water soluble bags) applied by commercial applicators.

**Table 5 Residential Postapplication Object-to-Mouth Incidental Oral Exposure and Risk from Turf Use**

| Lifestage <sup>a</sup> | Formulation         | Object Residue <sup>b</sup><br>( $\mu\text{g}/\text{cm}^2$ ) | Oral Exposure (mg/kg bw/day) <sup>c</sup> | Incidental Oral MOE <sup>d</sup> |
|------------------------|---------------------|--------------------------------------------------------------|-------------------------------------------|----------------------------------|
| Children 1 to <2 year  | Liquid <sup>e</sup> | 0.02810                                                      | 0.00012                                   | 70000                            |
|                        | Granules            | 0.02800                                                      | 0.00012                                   | 70000                            |

MOE = Margin of Exposure

<sup>a</sup> Children 1 to < 2 year has been chosen as the index lifestage to assess based on their behavioral characteristics (likelihood of putting hand in mouth following potential dermal imidacloprid exposure) and the strengths and limitations of the available data.

<sup>b</sup> Where Object residue ( $\mu\text{g}/\text{cm}^2$ ) = application rate ( $0.0000281\text{ kg a.i.}/\text{m}^2$  for the liquid formulation,  $0.000028\text{ kg a.i.}/\text{m}^2$  for granules)  $\times$  Fraction of transferable a.i. ( $0.01$ )  $\times$  Weight conversion factor  $\mu\text{g}/\text{kg}$  ( $1 \times 10^9$ )  $\times$  Area conversion factor  $\text{m}^2/\text{cm}^2$  ( $0.0001$ )

<sup>c</sup> Exposure (mg/day) = Object residue ( $\mu\text{g}/\text{cm}^2$ )  $\times$  Conversion factor  $\text{mg}/\mu\text{g}$  ( $0.001$ )  $\times$  Surface area of object ( $10\text{ cm}^2/\text{event}$ )  $\times$  (Exposure time ( $1.5\text{ hours}/\text{day}$ )  $\times$  Number of replenishment intervals per hour ( $4\text{ intervals}/\text{hr}$ ))  $\times$  [1 - (1-Saliva extraction factor ( $0.48$ ))<sup>2</sup> Number of object-to-mouth contact events per hour ( $8.8\text{ events}/\text{hr}$ ) / Number of replenishment intervals per hour ( $4\text{ intervals}/\text{hr}$ )] / body weight ( $11\text{ kg}$  for children 1 to <2 years). Calculated according to the USEPA Residential SOPs 2012.

<sup>d</sup> Incidental Oral MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of  $8\text{ mg}/\text{kg bw}/\text{day}$  for short-intermediate term scenarios. Target MOE = 100.

<sup>e</sup> Liquid formulation refers to registered turf treatment in wettable powder form (in water soluble bags) applied by commercial applicators.

**Table 6 Residential Postapplication Soil Incidental Oral Exposure and Risk from Turf Use**

| Lifestage <sup>a</sup> | Formulation         | SR <sub>t</sub> <sup>b</sup> ( $\mu\text{g}/\text{g}$ ) | Oral Exposure <sup>c</sup> (mg/kg bw/day) | Incidental Oral MOE <sup>d</sup> |
|------------------------|---------------------|---------------------------------------------------------|-------------------------------------------|----------------------------------|
| Children 1 to <2 year  | Liquid <sup>e</sup> | 1.883                                                   | $8.6 \times 10^{-6}$                      | 900000                           |
|                        | Granules            | 1.876                                                   | $8.5 \times 10^{-6}$                      | 900000                           |

MOE = Margin of Exposure, SR = Soil Residue

<sup>a</sup> Children 1 to < 2 year has been chosen as the index lifestage to assess based on their behavioral characteristics (likelihood of putting hand in mouth following potential dermal imidacloprid exposure) and the strengths and limitations of the available data.

<sup>b</sup> SR<sub>t</sub> ( $\mu\text{g}/\text{g}$ ) = Application rate ( $0.0000281\text{ kg a.i.}/\text{m}^2$  for the liquid formulation,  $0.000028\text{ kg a.i.}/\text{m}^2$  for granules)  $\times$  Fraction a.i. available in uppermost cm of soil ( $1/\text{cm}$ )  $\times$  (1 - Fraction of residue that dissipates daily ( $0.1$ ))  $\times$  Weight conversion factor,  $\mu\text{g}/\text{kg}$  ( $1.0 \times 10^9$ )  $\times$  Area conversion factor ( $\text{m}^2/\text{cm}^2$ )  $\times$  Soil volume to weight conversion factor ( $0.67\text{ cm}^3/\text{g soil}$ )

<sup>c</sup> Exposure (mg/day) = Soil residue ( $\mu\text{g}/\text{g}$ )  $\times$  Conversion factor  $\text{g}/\mu\text{g}$  ( $1.0 \times 10^{-6}$ )  $\times$  Ingestion Rate ( $50\text{ mg}/\text{day}$ ) / body weight ( $11\text{ kg}$  for children 1 to < 2 years). Calculated according to the USEPA residential SOPs 2012.

<sup>d</sup> Incidental Oral MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of  $8\text{ mg}/\text{kg bw}/\text{day}$  for short-intermediate term scenarios. Target MOE = 100.

<sup>e</sup> Liquid formulation refers to registered turf treatment in wettable powder form (in water soluble bags).

**Table 7 Residential Postapplication Granule Incidental Oral Exposure and Risk from Turf Use**

| Lifestage <sup>a</sup> | Formulation       | % Active Ingredient in Product | Oral Exposure <sup>b</sup><br>(mg/kg bw/day) | Incidental Oral MOE <sup>c</sup> |
|------------------------|-------------------|--------------------------------|----------------------------------------------|----------------------------------|
| Children 1 to <2 year  | Granules/Pellets  | 0.5 % (commercial)             | 0.05                                         | 180                              |
|                        | Granules /Pellets | 0.25 % (domestic)              | 0.02                                         | 350                              |

MOE = Margin of Exposure

<sup>a</sup> Children 1 to <2 year has been chosen as the index lifestage to assess based on their behavioral characteristics (likelihood of putting hand in mouth following potential dermal imidacloprid exposure) and the strengths and limitations of the available data.<sup>b</sup> Exposure (mg/day) = % active ingredient in product (0.5% for commercial granules/pellets, 0.25% for domestic granules/pellets) × Ingestion rate (0.1 g/day) × Weight conversion factor mg/g (1000)/body weight (11 kg for children). Calculated according to the USEPA Residential SOPs 2012.<sup>c</sup> Incidental Oral MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100**Table 8 Residential Postapplication Incidental Oral Exposure and Risk to Treated Pets**

| Lifestage <sup>a</sup> | Animal Type | Animal Size         | Surface Area of Pet <sup>b</sup><br>(cm <sup>2</sup> /animal) | Hand Residue Loading <sup>c</sup> (mg/cm <sup>2</sup> ) | Oral Exposure <sup>d</sup><br>(mg/kg bw/day) | Incidental Oral MOE <sup>e</sup> |
|------------------------|-------------|---------------------|---------------------------------------------------------------|---------------------------------------------------------|----------------------------------------------|----------------------------------|
| Children 1 to <2 yr    | Dog         | Small               | 1989                                                          | $1.1 \times 10^{-7}$                                    | $7.2 \times 10^{-7}$                         | 11000000                         |
|                        |             | Medium              | 2914                                                          | $1.8 \times 10^{-7}$                                    | $1.2 \times 10^{-6}$                         | 7000000                          |
|                        |             | Large               | 5210                                                          | $2.5 \times 10^{-7}$                                    | $1.7 \times 10^{-6}$                         | 5000000                          |
|                        |             | Extra-Large         | 8883                                                          | $2.4 \times 10^{-7}$                                    | $1.6 \times 10^{-6}$                         | 5000000                          |
|                        | Cat         | Small <sup>f</sup>  | 1500                                                          | $1.2 \times 10^{-7}$                                    | $1.0 \times 10^{-6}$                         | 8000000                          |
|                        |             | Medium <sup>f</sup> | 2500                                                          | $1.6 \times 10^{-7}$                                    | $1.1 \times 10^{-6}$                         | 7000000                          |

MOE = Margin of Exposure

<sup>a</sup> Children 1 to <2 year has been chosen as the index lifestage to assess based on their behavioral characteristics (likelihood of putting hand in mouth following potential dermal imidacloprid exposure) and the strengths and limitations of the available data.<sup>b</sup> Surface Area (cm<sup>2</sup>) = ((12.3\*(BW (kg)\*1000 g/kg)<sup>0.65</sup>)) as stated in the USEPA Residential SOPs 2012.<sup>c</sup> Hand residue loading (mg/cm<sup>2</sup>) = Fraction a.i.on hands compared to total surface residue (0.15) × Exposure (mg/day)/Typical Surface Area of one hand (cm<sup>2</sup>) × 2<sup>d</sup> Incidental Oral Exposure (mg/day) estimates were calculated according to the USEPA Residential SOP 2012. Body weight = 11 kg (children 1 to <2 years).<sup>e</sup> Incidental Oral MOE = NOAEL/Exposure. NOAEL is based on oral NOAEL of 8 mg/kg bw/day for short-intermediate term scenarios. Target MOE = 100<sup>f</sup> Default surface area values from the USEPA Residential SOPs 2012 were used for cat animal sizes, as those values were more protective than using the weights specified by the product labels.





## Appendix VIII Aggregate Risk Assessment

Table 1 Aggregate Residential and Chronic Dietary Exposure and Risk

| Life Stage           | Form <sup>a</sup> | Residential Scenario |                             | Exposure (mg/kg bw/day) <sup>b</sup> |                      |                      |                      |                    | Aggregate MOE <sup>f</sup> |
|----------------------|-------------------|----------------------|-----------------------------|--------------------------------------|----------------------|----------------------|----------------------|--------------------|----------------------------|
|                      |                   | Application          | PA                          | Applicator <sup>c</sup>              | PA Dermal            | PA IO                | Dietary <sup>d</sup> | Total <sup>e</sup> |                            |
| TURF USE             |                   |                      |                             |                                      |                      |                      |                      |                    |                            |
| Adult                | Liquid            | -                    | HCLA <sup>g</sup>           | -                                    | 0.0048               | -                    | 0.0025               | 0.0073             | 1103                       |
|                      | Granule           | Rotary Spreader      | HCLA <sup>g</sup>           | $6.7 \times 10^{-5}$                 | 0.0011               | -                    | 0.0025               | 0.0011             | 7164                       |
|                      |                   | Belly Grinder        | HCLA <sup>g</sup>           | 0.0013                               | 0.0011               | -                    | 0.0025               | 0.0023             | 3412                       |
|                      |                   | Hand Dispersal       | HCLA <sup>g</sup>           | $2.8 \times 10^{-6}$                 | 0.0011               | -                    | 0.0025               | 0.0011             | 7598                       |
| Youth 11 to <16 yr   | Liquid            | -                    | HCLA <sup>g</sup>           | -                                    | 0.0048               | -                    | 0.0026               | 0.0073             | 1092                       |
|                      | Granule           | -                    | HCLA <sup>g</sup>           | -                                    | 0.0011               | -                    | 0.0026               | 0.0036             | 2205                       |
| Children 6 to <11 yr | Liquid            | -                    | Golfing                     | -                                    | 0.0004               | -                    | 0.0046               | 0.0050             | 1600                       |
|                      | Granule           | -                    | Golfing                     | -                                    | 0.0004               | -                    | 0.0046               | 0.0050             | 1600                       |
| Children 1 to <2 yr  | Liquid            | -                    | HCLA + HTM <sup>h</sup>     | -                                    | 0.0094               | 0.0039               | 0.0107               | 0.0240             | 334                        |
|                      | Granule           | -                    | HCLA + HTM <sup>h</sup>     | -                                    | 0.0021               | 0.0004               | 0.0107               | 0.0132             | 608                        |
| PET USE              |                   |                      |                             |                                      |                      |                      |                      |                    |                            |
| Adults               | Liquid            | Spot On              | Large Dog <sup>h</sup>      | $1.9 \times 10^{-7}$                 | $3.4 \times 10^{-6}$ | -                    | 0.0025               | 0.0025             | 3189                       |
| Youth 11 to <16 yr   | Liquid            | -                    | Large Dog <sup>h</sup>      | -                                    | $4.7 \times 10^{-6}$ | -                    | 0.0026               | 0.0026             | 3094                       |
| Children 1 to <2 yr  | Liquid            | -                    | Large Dog <sup>h</sup> + IO | -                                    | $8.6 \times 10^{-6}$ | $1.7 \times 10^{-6}$ | 0.0107               | 0.0107             | 745                        |

PA = postapplication, Form = formulation, IO = incidental oral, MOE = margin of exposure, HCLA = high contact lawn activities, HTM = hand-to-mouth,

<sup>a</sup> Liquid formulation refers to registered turf treatment in wettable powder form (in water soluble bags) applied by commercial applicators.

<sup>b</sup> Residential exposure estimates for application and postapplication activities are derived from estimates in Appendix VII (Tables 1 to 8).

<sup>c</sup> Applicator exposure is the sum of dermal and inhalation exposure for turf use and dermal exposure for spot on treatment to pets.

<sup>d</sup> Chronic food and drinking water exposure estimates for adults, youth 11 to < 16 years, children 6 to <11 years, children 1 to <2 years.

<sup>e</sup> Total Exposure = Applicator + PA Dermal Route + PA Incidental Oral Route + Chronic Dietary

<sup>f</sup> Aggregate MOE = Aggregate NOAEL (8 mg/kg bw/day) for short-intermediate term / Total Exposure. Target MOE = 100.

<sup>g</sup> For turf use, the postapplication dermal exposure estimate for high contact lawn activities was used as it has the highest postapplication exposure and addresses other postapplication activities such as mowing and golfing.

<sup>h</sup> The aggregate postapplication dermal + HTM + chronic dietary assessment addresses the aggregate soil ingestion scenario.

<sup>i</sup> For pet use, the dermal exposure estimate for the large dog scenario was used as it has the highest application and postapplication exposure and addresses other pet uses. The incidental oral exposure estimate was based on pet treatment of the commercial product as this scenario has the highest exposure.



# Appendix IX      Fate, Toxicity, and Risks to the Environment

**Table 1a Summary of Fate Processes for Imidacloprid in the Terrestrial and Aquatic Environment – Abiotic and Biotic Transformation**

| Process                                                                              | T <sub>1/2</sub> or DT <sub>50</sub><br>(days)                                                                                                    | DT <sub>90</sub><br>(days) | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> ) | Comments                                                                                                                                                                                                                                                                                                                                                                                    | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Abiotic transformation</b>                                                        |                                                                                                                                                   |                            |                                                       |                                                                                                                                                                                                                                                                                                                                                                                             |                                                              |
| Hydrolysis<br>Technical, 25°C, 30 days                                               | pH 5: Stable<br>pH 7: Stable<br>pH 9: 346                                                                                                         | nr                         | SFO                                                   | Resistant to hydrolysis at environmental pH                                                                                                                                                                                                                                                                                                                                                 | 1155840                                                      |
| Hydrolysis<br>Technical                                                              | pH 10.8: 20<br>pH 11.8: 2.85                                                                                                                      | nr                         | SFO                                                   | Hydrolysis is shown to occur under highly alkaline conditions; these conditions are not considered environmentally relevant.                                                                                                                                                                                                                                                                | 2535318 / (2332664 and 2334762)                              |
| Phototransformation soil<br>Technical, sandy loam soil, pH 5.2, 1.4% OC, 25°C, 15 d. | 38.9 (continuous irradiation)<br><br>171 (predicted environmental – midsummer sunlight at 40° latitude)                                           | nr                         | SFO                                                   | Photolysis is shown to range considerably in soil (18 hours to 38.9 days under continuous irradiation). The reason for the difference between studies is unclear but may be due to differing soil conditions (for example, soil moisture, adsorption to soil, light penetration into soil, microbial activity).<br><br>Photolysis not a pathway for transformation of the compound on soil. | 1155829 / (2332664 and 2334762)                              |
| Phototransformation soil<br>Technical, sandy soil, pH 5.5, 2.7% OM, 25°C, 6 h.       | Continuous irradiation – reported equivalent to natural sunlight in Phoenix at noon in June<br><br>19.2 (moist soil)<br><br>34.6 (air dried soil) | nr                         | SFO                                                   |                                                                                                                                                                                                                                                                                                                                                                                             | 2332668 / 2334762                                            |
| Phototransformation soil<br>Technical, sandy soil, pH 7.1, 1.14% OM, 20°C, 32 h.     | 18 hours<br>Authors claim that the apparatus used exhibits a radiation close to natural sunlight.                                                 | nr                         | SFO                                                   |                                                                                                                                                                                                                                                                                                                                                                                             | 2334719                                                      |
| Phototransformation water<br>Technical, pH 7, 23°C, 2h.                              | < 1 hour (continuous irradiation)<br><br>4.2 hours (predicted environmental – summer sunlight at 35° latitude)                                    | nr                         | SFO                                                   |                                                                                                                                                                                                                                                                                                                                                                                             | 1155834 / (2332664, 2332663 and 2334762)                     |
| Phototransformation water<br>Technical, pH – nr, 25°C                                | < 1 hour (continuous irradiation; predicted environmental half-life not reported)                                                                 | nr                         | SFO                                                   |                                                                                                                                                                                                                                                                                                                                                                                             | 2332667                                                      |



| Process                                                                                                           | T <sub>1/2</sub> or DT <sub>50</sub><br>(days)                                                                                                                                                                                                                    | DT <sub>90</sub><br>(days) | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> ) | Comments                                                                                                                                                                                                                                                                                                                                                                                                       | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| Phototransformation water<br>Technical, pH – nr, 25°C, 1.3 h                                                      | < 1 hour (continuous irradiation;<br>predicted environmental half-life not<br>reported)                                                                                                                                                                           | nr                         | SFO                                                   | Rapidly phototransformed in water. Additional<br>experiments conducted with photosensitizers. Under<br>the irradiation of black light fluorescent lamp,<br>photosensitizers (acetone, hydrogen peroxide and<br>titanium dioxide) were shown to accelerate the<br>photodegradation in aqueous solution. Under UV<br>irradiation, however, addition of acetone inhibited<br>phototransformation of imidacloprid. | 2332670                                                      |
| Phototransformation water<br>Technical and Confidor, pH – nr, 25°C, ~12<br>h                                      | t <sub>1/2</sub> (technical) = less than one hour<br>t <sub>1/2</sub> (Confidor) = 2.1 hours<br>t <sub>1/2</sub> (Confidor + TiO <sub>2</sub> ) = 2.4 hours<br><br>All experiments: continuous<br>irradiation; predicted environmental<br>half-life not reported. | nr                         | SFO                                                   | Rapidly transformed in water. Coloured components of<br>the formulation were shown to slow the rate of<br>transformation.                                                                                                                                                                                                                                                                                      | 2332671                                                      |
| <b>Aerobic Soil Biotransformation</b>                                                                             |                                                                                                                                                                                                                                                                   |                            |                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                |                                                              |
| Loamy soil (BBA2.2): pH 6.3, 2.15% OC,<br>20°C, ~365 days                                                         | 157                                                                                                                                                                                                                                                               | 557                        | DFOP (172 days)                                       | Moderately persistent                                                                                                                                                                                                                                                                                                                                                                                          | 1155830                                                      |
| Silt soil (Höfchen): pH 5.5, 1.23% OC,<br>20°C, ~365 days                                                         | 273                                                                                                                                                                                                                                                               | 6065                       | IORE (1830 days)                                      | Persistent                                                                                                                                                                                                                                                                                                                                                                                                     | 1155832                                                      |
| Sandy loam (Monheim): pH 6.76, 1.31%<br>OC, 20°C, ~365 days                                                       | 453                                                                                                                                                                                                                                                               | 2615                       | DFOP (931 days)                                       | Persistent                                                                                                                                                                                                                                                                                                                                                                                                     | 1155864                                                      |
| Sandy loam (Kansas): pH 6.5, 1.4% OC,<br>20°C, ~365 days                                                          | 973                                                                                                                                                                                                                                                               | 4072                       | DFOP (1330 days)                                      | Persistent                                                                                                                                                                                                                                                                                                                                                                                                     | 1155838                                                      |
| Soil: pH 6.0, 17.24 g/kg OM, 28°C, 25 days<br><br>Soil characteristics not reported.                              | 173.3                                                                                                                                                                                                                                                             | nr                         | SFO                                                   | Moderately persistent                                                                                                                                                                                                                                                                                                                                                                                          | 2332676                                                      |
| Sandy loam (Exeter): pH 4.6, 0.21% OC<br><br>Silty clay loam (Drummer): pH 5.6, 4.49%<br>OC<br><br>25°C, 400 days | > 400<br>Variability and biphasic transformation prevented adequate assessment of the<br>transformation kinetics; the DT <sub>50</sub> values were reported as greater than 400 days.                                                                             |                            |                                                       | Persistent                                                                                                                                                                                                                                                                                                                                                                                                     | 2332677                                                      |

| Process                                                                                                                                   | T <sub>1/2</sub> or DT <sub>50</sub><br>(days) | DT <sub>90</sub><br>(days)             | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> ) | Comments              | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|----------------------------------------|-------------------------------------------------------|-----------------------|--------------------------------------------------------------|
| <b>Anaerobic Soil Biotransformation</b>                                                                                                   |                                                |                                        |                                                       |                       |                                                              |
| A laboratory anaerobic soil biotransformation study was not available for review.                                                         |                                                |                                        |                                                       |                       |                                                              |
| <b>Aerobic Aquatic Biotransformation</b>                                                                                                  |                                                |                                        |                                                       |                       |                                                              |
| Kansas water/sediment system<br>Water: pH 8.6, TOC = 4.3 mg/L<br>Sediment: Silty clay, pH 7.62, 3.1% OC<br>22°C, 30 days, darkness        | Water phase: 160<br>Whole system: 126          | Water phase: 762<br>Whole system: 419  | DFOP (259 days)<br>SFO                                | Moderately persistent | 2142816                                                      |
| Kansas water/sediment system<br>Water: pH 8.6, TOC = 4.3 mg/L<br>Sediment: Silty clay, pH 7.62, 3.1% OC<br>22°C, 30 days, darkness        | Water phase: 160<br>Whole system: 126          | Water phase: 762<br>Whole system: 419  | DFOP (259 days)<br>SFO                                | Moderately persistent | 2142816                                                      |
| Ijzendoorn water/sediment system<br>Water: pH 7.9 - 8.4<br>Sediment: loamy silt, 4.1% OC<br>22°C, 92 days, darkness                       | Water phase: 18.2<br>Whole system: 31.5        | Water phase: 60.4<br>Whole system: 105 | SFO<br>SFO                                            | Slightly persistent   | 2142817                                                      |
| Lienden water/sediment system<br>Water: pH 8.1 - 8.9<br>Sediment: loamy sand, 0.8% OC<br>22°C, 92 days, darkness                          | Water phase: 138<br>Whole system: 159          | Water phase: 542<br>Whole system: 529  | DFOP (174 days)<br>SFO                                | Moderately persistent |                                                              |
| Pondwater (Norfolk County, Ontario)<br>Water pH: 7.73 - 9.01<br>22°C, 366 days, darkness                                                  | Water phase: 331<br>(no sediment used)         | nr                                     | SFO                                                   | Persistent            | 1182373                                                      |
| Pondwater (Norfolk County, Ontario)<br>Water pH: 7.71 - 9.30<br>22°C, 366 days, exposed to artificial light<br>(12 hour light/dark cycle) | Water phase: 4.2<br>(no sediment used)         | nr                                     | SFO                                                   | Non persistent        |                                                              |

| Process                                                                                        | T <sub>1/2</sub> or DT <sub>50</sub><br>(days) | DT <sub>90</sub><br>(days) | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> ) | Comments            | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|------------------------------------------------------------------------------------------------|------------------------------------------------|----------------------------|-------------------------------------------------------|---------------------|--------------------------------------------------------------|
| <b>Anaerobic Aquatic Biotransformation</b>                                                     |                                                |                            |                                                       |                     |                                                              |
| Kansas water/sediment system<br>Water: 6.9 – 7.4, TOC = 5 mg/L.<br>Sediment: pH 6.89, 3.15% OC | Whole system: 27                               | nr                         | SFO                                                   | Slightly persistent | 1155865                                                      |

DFOP = double first order in parallel; IORE = Indeterminate Order Rate Equation model; nr = not reported; OC = organic carbon content; OM = organic matter content; SFO = single first order

**Table 1b Summary of Fate Processes for Imidacloprid in the Terrestrial and Aquatic Environment – Mobility**

| Process                     | Soil type                                                                                                                                                                        | K <sub>d</sub> or K <sub>f</sub> (1/n) | K <sub>oc</sub> | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| Adsorption:<br>Imidacloprid | Twelve soils: sand, 6 sandy loam, loamy sand, silt loam, silt, silt clay and loam                                                                                                | 0.96 to 4.18 (0.76 – 0.89)             | 109 - 411       | The arithmetic mean (n=12) for the K <sub>oc</sub> is 225 ± 87.                                                                                                                                                                                                                                                                                                                                                                                                    | 2332663                                                      |
|                             | Seven soils: fine sand (Winder), silty clay loam (Drummer), fine sandy loam (Hanford), sandy loam (Tifton), silty clay (Oskamartin), silt loam (Crane), silty clay loam (Dundee) | 0.12 – 13.3                            | 41 - 433        | Adsorption data determined for three concentrations for each soil (3, 50 and 100 µg /ml.). K <sub>d</sub> /K <sub>oc</sub> values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:1.                                                                                                                                                                                                                            | 2142713 / (2332664 and 2332665)                              |
|                             | Sandy loam (day 0)                                                                                                                                                               | 4.82                                   | 249             | Calculated sorption coefficients K <sub>d</sub> and K <sub>oc</sub> determined in soil after selected aging periods (0, 2, 7, 14, 28, 56 and 100 days). K <sub>d</sub> /K <sub>oc</sub> values increased by a factor of 3.2 – 3.8 during 100 days of aging. K <sub>d</sub> and K <sub>oc</sub> values for day 0 and 100 only were reported in the study. K <sub>d</sub> /K <sub>oc</sub> values were calculated from a single initial solution concentration data. | 2535320, 2142716                                             |
|                             | Sandy loam (day 100)                                                                                                                                                             | 15.6                                   | 869             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |
|                             | Silt loam (day 0)                                                                                                                                                                | 2.24                                   | 268             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |
|                             | Silt loam (day 100)                                                                                                                                                              | 8.6                                    | 960             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                              |

| Process | Soil type                                                                                                            | $K_d$ or $K_f$ (1/n)         | $K_{oc}$    | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PMRA Reference (original study / foreign review) |
|---------|----------------------------------------------------------------------------------------------------------------------|------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
|         | Five soils: P1, P6, P7, P10, P12                                                                                     | 3.36 - 8.95                  | 269 - 830   | The study assessed the influence of different components of the clay fraction in five soils and model sorbents (montmorillonite, Fe oxide and humic acid and their binary and ternary associations on sorption); results shown in this table are for unadulterated soils, not for model sorbents. Freundlich isotherms ( $K_f$ , $K_{foc}$ ) were determined for soils treated in the range of 0.05 - 1.5 mg/L (4 concentrations). The overall results demonstrated that adsorption on clay soils increases with organic matter content. | 2142724                                          |
|         | Four soils: sandy loam (Kansas), silt (Höfchen), standard soil (2.1), silty clay (Ransbach)                          | 0.36 - 0.95                  | 47.6 - 94.8 | Highly mobile                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1155827                                          |
|         | Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC) | 0.55 - 16.9                  | 158 - 779   | It is uncertain as to whether the adsorption coefficients ( $K_d$ ) were determined from linear isotherms or single point adsorption data. Brazilian soils.                                                                                                                                                                                                                                                                                                                                                                              | 1086407                                          |
|         | Clay loam (Webster)                                                                                                  | 17.6 (non aged)<br>40 (aged) | 429<br>975  | Soils were aged for 16 weeks. Results indicate that adsorption increases with soil ageing. $K_d$ values were calculated from single initial concentration data.                                                                                                                                                                                                                                                                                                                                                                          | 1172514                                          |
|         | Silt loam (Waukegan)                                                                                                 | 7.1 (non aged)<br>17 (aged)  | 394<br>944  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  |
|         | Sandy loam (Verndale)                                                                                                | 7.05 (non aged)<br>20 (aged) | 435<br>1428 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  |
|         | Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)                                         | 1.0 - 64                     | 71 - 1560   | Adsorption data determined for three concentrations for each soil (0.05, 1.5 and 250 g/mL). $K_d/K_{oc}$ values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5. Results indicate that adsorption of imidacloprid is affected by initial solution concentration, in addition to soil properties such as the soil organic carbon content and % clay content (affinity is less at higher soil solution concentration, resulting in a high potential for mobility).                    | 2142715                                          |
|         | Six soils: S1 - S6                                                                                                   | 0.61 - 5.09 (0.72 - 0.93)    | 102 - 243   | Percent organic matter content and $K_{om}$ values were presented in the study.                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2332667                                          |
|         | Clay soil                                                                                                            | 1.43 (0.76)                  | 210         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2334736                                          |
|         | Sandy soil                                                                                                           | 0.39 (1.12)                  | 59          | Adsorption was shown to increase with organic amendments; $K_d$ increased from 0.75 to 4.25 for three organic amendments tested.                                                                                                                                                                                                                                                                                                                                                                                                         | 2334719                                          |
|         | Heavy clay (Bornsön)                                                                                                 | 3.08                         | 130         | Adsorption was shown to increase with biochar amendment; $K_d$ increased to 6.19                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 2358285                                          |



| Process                            | Soil type                                                                                                            | K <sub>d</sub> or K <sub>f</sub> (1/n)                                                                                                                               | K <sub>oc</sub> | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | PMRA Reference (original study / foreign review) |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
|                                    | Loam (Säby)                                                                                                          | 4.40                                                                                                                                                                 | 150             | and 7.40 (Bornsjö and Säby, respectively).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                  |
|                                    | Sandy clay loam                                                                                                      | Low percent sorption over the test period; the average percent adsorption increased to 20.43% within the first 24 hours and increased further to 24.04% by 96 hours. |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2334741                                          |
|                                    | Four surface soils and one acid washed sand                                                                          | 2.4 – 7.6 (after 24h)<br>3.5 – 9.4 (after 28 days)                                                                                                                   | nr              | <sup>14</sup> C imidacloprid was used and measured via I.S.C. Transformation products such as imidacloprid-guanidine, imidacloprid-guanidine-olefin, and imidacloprid-urea may have been produced over the course of the study. Imidacloprid-guanidine and imidacloprid-guanidine-olefin are known to adsorb more strongly to soil than parent imidacloprid. The increase in adsorption with time may have been due to increases in these or other transformation products. The K <sub>d</sub> values are expected to be representative of parent and increasing amounts of transformation products with time. | 2334745                                          |
| Adsorption: Imidacloprid-guanidine | Clay loam (Webster)                                                                                                  | 53.4 (non aged)<br>126 (aged)                                                                                                                                        | 1302<br>3073    | Soils were aged for 16 weeks. Results indicate that adsorption increases with soil ageing. K <sub>d</sub> values were calculated from single initial concentration data.                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2142719                                          |
|                                    | Silt loam (Waukegan)                                                                                                 | 40.2 (non aged)<br>90.6 (aged)                                                                                                                                       | 2233<br>5033    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |
|                                    | Sandy loam (Verndale)                                                                                                | 31.4 (non aged)<br>71.1 (aged)                                                                                                                                       | 2243<br>5078    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |
|                                    | Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)                                         | 36.8 – 351                                                                                                                                                           | 2627 – 8571     | Adsorption data determined for two concentrations for each soil (0.05 and 1.5 g/mL). K <sub>d</sub> /K <sub>oc</sub> values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5.                                                                                                                                                                                                                                                                                                                                                                              | 2142715                                          |
|                                    | Four soils: sand (#396), loamy sand (#398), silt loam (#307), loam (#318)                                            | 2.14 – 15.53                                                                                                                                                         | 394 – 1254      | Low to medium mobility                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1155825                                          |
|                                    | Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC) | 4.74 – 134                                                                                                                                                           | 921 – 9219      | It is uncertain as to whether the adsorption coefficients (K <sub>d</sub> ) were determined from linear isotherms or single point adsorption data. Brazilian soils.                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1086407                                          |
|                                    | Fine sandy loam (Hanford)                                                                                            | 6.75 (0.92)                                                                                                                                                          | 1646            | Low mobility                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2142714                                          |
|                                    | Silty clay loam (Drummer)                                                                                            | 42.2 (0.83)                                                                                                                                                          | 1068            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |
| Adsorption: Imidacloprid-urea      | Clay loam (Webster)                                                                                                  | 6.80 (non aged)<br>14.1 (aged)                                                                                                                                       | 165<br>343      | Soils were aged for 16 weeks. Results indicate that adsorption increases with soil ageing. K <sub>d</sub> values were calculated from single initial concentration data.                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2142719                                          |
|                                    | Silt loam (Waukegan)                                                                                                 | 3.03 (non aged)<br>7.46 (aged)                                                                                                                                       | 168<br>414      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |

| Process                                   | Soil type                                                                                                                                                                                                                                                                                                                                                                                                                                                            | K <sub>d</sub> or K <sub>f</sub> (l/n) | K <sub>oc</sub> | Comments                                                                                                                                                                                                                          | PMRA Reference (original study / foreign review) |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
|                                           | Sandy loam (Verndale)                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2.90 (non aged)<br>9.61 (aged)         | 207<br>686      |                                                                                                                                                                                                                                   |                                                  |
|                                           | Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)                                                                                                                                                                                                                                                                                                                                                                                         | 2.92 - 16.9                            | 199 - 411       | Adsorption data determined for two concentrations for each soil (0.05 and 1.5 g/mL). K <sub>d</sub> /K <sub>oc</sub> values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5. | 2142715                                          |
|                                           | Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC)                                                                                                                                                                                                                                                                                                                                                 | 0.31 - 9.50                            | 72 - 309        | It is uncertain as to whether the adsorption coefficients (K <sub>d</sub> ) were determined from linear isotherms or single point adsorption data. Brazilian soils.                                                               | 1086407                                          |
| Adsorption: Imidacloprid-guanidine-olefin | Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)                                                                                                                                                                                                                                                                                                                                                                                         | 43.1 - 244                             | 3081 - 7672     | Adsorption data determined for two concentrations for each soil (0.05 and 1.5 g/mL). K <sub>d</sub> /K <sub>oc</sub> values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5. | 2142715                                          |
|                                           | Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC)                                                                                                                                                                                                                                                                                                                                                 | 2.87 - 72.3                            | 487 - 4695      | It is uncertain as to whether the adsorption coefficients (K <sub>d</sub> ) were determined from linear isotherms or single point adsorption data. Brazilian soils.                                                               | 1086407                                          |
| Soil column leaching                      | <sup>14</sup> C imidacloprid was added to soil columns (sandy loam) and aged 30 days prior to leaching. 48.5% of the <sup>14</sup> C activity remained in the upper soil layer of the columns with 54.2% found in the soil column segments. The leachate contained ~0.14% of <sup>14</sup> C activity.                                                                                                                                                               |                                        |                 |                                                                                                                                                                                                                                   | 1155853                                          |
|                                           | Four soils and 1 sand: 27 to 69% of the <sup>14</sup> C activity leached from soil columns. 97% leached from the sand column.                                                                                                                                                                                                                                                                                                                                        |                                        |                 |                                                                                                                                                                                                                                   | 2358286                                          |
|                                           | The effect of soil amendment with biochar to the leaching potential of imidacloprid was investigated using soil columns (loam and clay soil). The results suggest that increased soil inorganic carbon reduces leaching potential of imidacloprid in soils.                                                                                                                                                                                                          |                                        |                 |                                                                                                                                                                                                                                   | 2535319                                          |
|                                           | Lysimeters were used to monitor transformation and transport of <sup>14</sup> C labelled imidacloprid through sandy loam soil cores. A total of 0.024 and 0.037% of the <sup>14</sup> C activity was detected in two lysimeters over two trial years. 93% of the <sup>14</sup> C activity was contained in the top 20 cm layer of the lysimeters with virtually no residues detected below 30 cm. The majority of the recovered radioactivity was present as parent. |                                        |                 |                                                                                                                                                                                                                                   | 1160858                                          |
| Prospective groundwater studies           | The potential for imidacloprid to leach through soil into groundwater was investigated in two small scale prospective ground water (PGW) monitoring studies (Monterey County - California and Montcalm County - Michigan). The results of the two PGW studies show that imidacloprid residues can persist in soil long after application and will migrate through soil.                                                                                              |                                        |                 |                                                                                                                                                                                                                                   | 1057483 and 898825                               |

nr = not reported

Table 1c Summary of Fate Processes for Imidacloprid in the Terrestrial and Aquatic Environment – Field Studies

| Process                                                                            | T <sub>1/2</sub> or DT <sub>50</sub><br>(days) | DT <sub>90</sub><br>(days) | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> )<br>(days) | Comments                                                                                                                                                        | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|------------------------------------------------------------------------------------|------------------------------------------------|----------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <b>Terrestrial field studies</b>                                                   |                                                |                            |                                                                 |                                                                                                                                                                 |                                                              |
| Harriston, Ontario<br>Silt loam (bare soil): pH 7.3, 6.2% OM, 1095 days            | 45 - 426                                       | >1095                      | SFO                                                             | Residual imidacloprid in soil at end of study was 12 – 13 % of the target application rate.                                                                     | 1174609                                                      |
| Harriston, Ontario<br>Loam (turf cover): pH 7.3, 4.0% OM, 1099 days                | 22 - 33                                        | 457 – 743                  | SFO                                                             | Residual imidacloprid in soil at end of study was <LOQ.                                                                                                         | 1174607                                                      |
| Summerland, BC<br>Sandy loam (turf cover): pH 7.6, 2.9% OM, 729 days               | 16 - 21                                        | <456                       | SFO                                                             | Residual imidacloprid in soil at end of study was <LOQ.                                                                                                         | 1174611                                                      |
| Kinkora, P.E.I.<br>Sandy loam (bare soil): pH 6.8, 3.03% OM, 1099 days             | 210 - 456                                      | >1099                      | SFO                                                             | Residual imidacloprid in soil at end of study was 77 - 86% of the target application rate.                                                                      | 1174608                                                      |
| Kinkora, P.E.I.<br>Sandy loam (planted with potatoes): pH 6.9, 2.57% OM, 1095 days | 63 - 178                                       | >1099                      | SFO                                                             | Residual imidacloprid in soil at end of study was 76 – 82% of the target application rate.                                                                      | 1174610                                                      |
| Sandy loam (Kirchlauter-Pettstadt): pH 6.5, 0.79% OC, 360 days                     | 178 – 216                                      | nr                         | SFO                                                             | Field trials were conducted in Germany. After the twelve months of test duration 31 to 44% of the initial concentration of imidacloprid were found in the soil. | 1155868 / 2332663                                            |
| Silty loam (Swisttal-Hohn): pH 6.8, 1.00% OC, 360 days                             | 185 – 208                                      | nr                         | SFO                                                             |                                                                                                                                                                 |                                                              |
| Silt loam (Hofchen): pH 6.8, 1.11% OM, 360 days                                    | 104 – 131                                      | nr                         | SFO                                                             |                                                                                                                                                                 |                                                              |
| Loam (Worms-Heppenheim): pH 7.4, 1.56% OC, 360 days                                | 197 – 228                                      | nr                         | SFO                                                             |                                                                                                                                                                 |                                                              |
| Sandy loam (Laacher Hof): pH 6.7, 1.27% OC, 360 days                               | 152 - 186                                      | nr                         | SFO                                                             |                                                                                                                                                                 |                                                              |
| Georgia loamy sand: pH 5.8, 2.0% OM, 365 days                                      | >365                                           | nr                         | SFO                                                             |                                                                                                                                                                 | 1155870 / 2332665                                            |

| Process                                                                                                                        | T <sub>1/2</sub> or DT <sub>50</sub><br>(days)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | DT <sub>90</sub><br>(days) | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> )<br>(days) | Comments                                                                                                                                                                                                           | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| Minnesota sandy loam: pH 6.3, 1.8% OM, 365 days                                                                                | >365                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | nr                         | SFO                                                             |                                                                                                                                                                                                                    | 1155835 / 2332665                                            |
| California sandy loam: pH 7.1, 1.1% OM, 365 days                                                                               | 146                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | nr                         | SFO                                                             |                                                                                                                                                                                                                    | 1155837 / 2332665                                            |
| Georgia loamy sand (turf): pH 5.8, 2.0% OM, 365 days                                                                           | 107                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | nr                         | SFO                                                             |                                                                                                                                                                                                                    | 1155836 / 2332665                                            |
| Minnesota loam (turf): pH 7.6, 5.1% OM, 120 days                                                                               | 61                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | nr                         | SFO                                                             |                                                                                                                                                                                                                    | 1155869 / 2332665                                            |
| Belgian silt loam: pH 6.8, 2.55% OC, 96 days (after sowing of treated sugar beets seed – 90 g a.i./ha)                         | 87 – 129 (amended with manure)<br>42(control)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | nr                         | nr                                                              | It was reported that there were no residues of the parent and the transformation products imidacloprid-urea, 6-chloronicotinic acid, and 6-hydroxynicotinic acid detected in the 10-20 cm soil layer in all plots. | 2350951                                                      |
| Belgian silt loam: pH 7.0, 1.25% OC, 96 days (after sowing of treated sugar beets seed – 90 g a.i./ha)                         | 105 – 124 (amended with manure)<br>44(control)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | nr                         | nr                                                              |                                                                                                                                                                                                                    | 2350950                                                      |
| Long-term field dissipation: repeated single seasonal application within apple orchard for 6 consecutive years (150 g a.i./L). | Maximum residues in soil were observed directly after application and declined to 50% or less of the initial value within 3 to 4 months. During the first three years, residues increased in soil (0 – 30 cm) after which residues reached a plateau level at all three sites. Although the results predominantly show that imidacloprid residues did not move beyond 30 cm depth, transformation products were not identified or quantified in the soil samples. The results, therefore, do not preclude the movement of transformation products beyond 20 -30 cm depth.                                                                                                                                                                                                                                                                                                            |                            |                                                                 |                                                                                                                                                                                                                    | 2464657                                                      |
| Long-term field dissipation: treated winter barley seed sown for 6 consecutive years (35 and 75 g a.i./100 kg seed).           | The maximum residues in soil were observed in the upper 20 cm layer; this was expected, since the upper soil layers were mixed by ploughing and harrowing. Cultivation activity may have led to some minor mixing of soil containing imidacloprid residues into the 20-30 cm layer. In the 30-50 cm layer residues were not detected. Residues in the 0-30 cm layer increased gradually during the first three years after which residues reached a plateau level and remained constant. The overall residue levels throughout the trials, however, were low. Overall, the results show that the use of treated seed does not result in the movement of imidacloprid residues beyond 30 cm depth. Transformation products were not identified or quantified in the soil samples; the results, therefore, do not preclude the movement of transformation products beyond 30 cm depth. |                            |                                                                 |                                                                                                                                                                                                                    | 2464661                                                      |
| Aquatic field studies                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                            |                                                                 |                                                                                                                                                                                                                    |                                                              |
| Outdoor mesocosms: 182 days; Imidacloprid SL200 (17.3% w/w)                                                                    | Imidacloprid was sprayed onto the surface of ponds at 0.6, 1.5, 3.8, 9.4 and 23.5 µg a.i./L (n=2 per treatment, 3 controls). SFO DT <sub>50</sub> values for the water column ranged from 5.7 to 13 days (average = 8.2 days). Whole system DT <sub>50</sub> values were calculated for the two highest test concentrations; values ranged from 10.6 to 29.9 days after both applications (average = 14.8 days).                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |                                                                 |                                                                                                                                                                                                                    | 2142729                                                      |
| Outdoor mesocosm: 7 days; imidacloprid (purity not reported)                                                                   | The rate of dissipation was followed in mesocosms treated with three pulses of imidacloprid (17.3 µg a.i./L.) at 7-day intervals. Overlying water was collected at 6 hours and 1, 2, 3 and 7 days after each pulse and 7 weeks after the 3 <sup>rd</sup> pulse. SFO DT <sub>50</sub> values for each of the three pulses was 20, 36 and 29                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                            |                                                                 |                                                                                                                                                                                                                    | 2544391                                                      |



| Process                                            | T <sub>1/2</sub> or DT <sub>50</sub><br>(days)                                                                                                                                                                                                                                                                                                                                                                                                                                     | DT <sub>90</sub><br>(days) | Kinetics<br>(T <sub>R</sub> or T <sub>1/2slow</sub> )<br>(days) | Comments | PMRA<br>Reference<br>(original study<br>/ foreign<br>review) |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------|----------|--------------------------------------------------------------|
|                                                    | hours. In other mesocosms containing benthic assemblages (treated at 0.6, 1.4, 3.2, 7.5, 17.3 and 40 µg a.i./L), concentrations were detectable in water 7 weeks after the 3 <sup>rd</sup> pulse (0.06 – 1.72 µg a.i./L), except at the lowest concentration (0.6 µg a.i./L); concentrations remained detectable in sediment in mesocosms treated with ≥ 7.5 µg a.i./L (0.02 to 0.13 µg /kg).                                                                                      |                            |                                                                 |          |                                                              |
| Outdoor mesocosms 56 days<br>Imidacloprid (~95.8%) | The rate of dissipation in water and sediment of mesocosms was followed for 56 days. Imidacloprid was sprayed onto the surface of ponds at 2, 6, 20, 60 and 180 µg a.i./L (n=3 per treatment, 11 controls); four applications were made at 2 week intervals. A half-life in the water column of 1.4 days is reported for after the last application. Imidacloprid did not accumulate in sediment and residues were below the detection limit two weeks after the last application. |                            |                                                                 |          | 1155896                                                      |

nr = not reported; OC = organic carbon content; OM = organic matter content; SFO = single first order

**Table 2 Summary of acute and chronic toxicity endpoints reported for soil dwelling invertebrates.**

| Species                              | Exposure                                        | Endpoint observed     | Value<br>(mg a.i./kg soil dw) | Reference                                                     |
|--------------------------------------|-------------------------------------------------|-----------------------|-------------------------------|---------------------------------------------------------------|
| <b>Acute</b>                         |                                                 |                       |                               |                                                               |
| Earthworm<br><i>Eisenia foetida</i>  | Technical imidacloprid<br>(92.8%)               | 14-d LC <sub>50</sub> | 10.7                          | EFSA 2008<br>(PMRA 2332663); (original study PMRA<br>1160913) |
|                                      | Confidor SL 200                                 | LC <sub>50</sub>      | 21.8                          | EFSA 2008<br>(PMRA 2332663)                                   |
|                                      | Not reported                                    | 7-d LC <sub>50</sub>  | 3.48                          | USDA 2005<br>PMRA (2334762)                                   |
|                                      |                                                 | 14-d LC <sub>50</sub> | 2.30                          |                                                               |
|                                      |                                                 | 7-d LC <sub>50</sub>  | 3.00                          |                                                               |
| Earthworms<br><i>Pheritima</i> group |                                                 | 24-h LC <sub>50</sub> | 155                           | Mostert et al. 2002; PMRA 2574040                             |
|                                      |                                                 | 48-h LC <sub>50</sub> | 5.00                          |                                                               |
|                                      |                                                 | 7-d LC <sub>50</sub>  | 3.00                          |                                                               |
| Earthworm<br><i>Eisenia andrei</i>   | Gaicho 600 FS (600 g a.i./L)                    | 14-d LC <sub>50</sub> | 25.53                         | Alves et al. 2013<br>(PMRA 2535324)                           |
| Earthworm<br><i>Eisenia foetida</i>  | Technical imidacloprid<br>(purity not reported) | 7-d LC <sub>50</sub>  | 12.04                         | Wang et al. 2012<br>(PMRA 2535323)                            |
|                                      |                                                 | 14-d LC <sub>50</sub> | 10.00                         |                                                               |
|                                      | Imidacloprid (95.3% purity)                     | 7-d LC <sub>50</sub>  | 2.34 – 4.03                   | Chen et al. 2014, (PMRA 2535325); EFSA<br>2014 (PMRA 2545413) |
|                                      |                                                 | 14-d LC <sub>50</sub> | 1.72 – 1.99                   |                                                               |
|                                      | Imidacloprid<br>(35% suspension concentrate)    | 7-d LC <sub>50</sub>  | 0.82                          | Chen et al. 2013 PMRA 2535327; EFSA 2014                      |
|                                      |                                                 | 14-d LC <sub>50</sub> | 0.77                          |                                                               |
|                                      | Imidacloprid                                    | 7-d LC <sub>50</sub>  | 6.44                          |                                                               |

| Species                                     | Exposure                                                                                                                                                                    | Endpoint observed                                                                                                                          | Value<br>(mg a.i./kg soil dw)                                                                                                                             | Reference                                                                |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Springtail<br><i>Folsomia candida</i>       | (70% wet seed dressing agent)                                                                                                                                               | 14-d LC <sub>50</sub>                                                                                                                      | 6.00                                                                                                                                                      | (PMRA 2545413)                                                           |
|                                             | Imidacloprid                                                                                                                                                                | 7-d LC <sub>50</sub>                                                                                                                       | 2.39                                                                                                                                                      |                                                                          |
|                                             | (70% wettable powder)                                                                                                                                                       | 14-d LC <sub>50</sub>                                                                                                                      | 2.12                                                                                                                                                      |                                                                          |
|                                             | Imidacloprid                                                                                                                                                                | 7-d LC <sub>50</sub>                                                                                                                       | 9.65                                                                                                                                                      |                                                                          |
|                                             | (600 g/L flowable concentrate)                                                                                                                                              | 14-d LC <sub>50</sub>                                                                                                                      | 8.60                                                                                                                                                      |                                                                          |
| Earthworm<br><i>Aporrectodea nocturna</i>   | Confidor (200g a.i./L)                                                                                                                                                      | 14-d LC <sub>50</sub>                                                                                                                      | 20.96                                                                                                                                                     | Alves <i>et al.</i> 2014, (PMRA 2535326)                                 |
| Earthworm<br><i>Allolobophora icterica</i>  | Confidor (200g a.i./L); 7 days                                                                                                                                              | Acetylcholinesterase and glutathione S-transferase activity.                                                                               | 3.74<br>(NOEC = 0.1, reduced body mass)                                                                                                                   | Capowiez 2005 (PMRA 2574030); WIA 2014a (PMRA 2545410)                   |
| Earthworm<br><i>Allolobophora icterica</i>  |                                                                                                                                                                             |                                                                                                                                            | 2.81<br>(NOEC = 0.1, reduced body mass)                                                                                                                   |                                                                          |
| Earthworm<br><i>Aporrectodea nocturna</i>   | Confidor (200g a.i./L); 7 days                                                                                                                                              | Acetylcholinesterase and glutathione S-transferase activity.                                                                               | Enzyme activity:<br>NOEC = 0.01<br>(no effect up to highest test concentration, 1.0)                                                                      | Capowiez 2003 (PMRA 2574029); WIA 2014a (PMRA 2545410)                   |
| Earthworm<br><i>Allolobophora icterica</i>  |                                                                                                                                                                             |                                                                                                                                            |                                                                                                                                                           |                                                                          |
| Earthworm<br><i>Aporrectodea nocturna</i>   | Biochemical marker tests:<br>0, 0.01, 0.1 and 1.0 mg a.i./kg soil dw.                                                                                                       | Burrowing behaviour                                                                                                                        | Burrowing behaviour (reduced):<br>LOEC = 0.5                                                                                                              |                                                                          |
| Earthworm<br><i>Allolobophora icterica</i>  |                                                                                                                                                                             |                                                                                                                                            |                                                                                                                                                           |                                                                          |
| Earthworm<br><i>Aporrectodea nocturna</i>   | Confidor (200g a.i./L); 6 days                                                                                                                                              | Body mass, burrowing behaviour                                                                                                             | Body mass, burrowing behaviour (reduced): LOEC = 0.5                                                                                                      | Capowiez and Berard 2006 (PMRA 2574031); WIA 2014a (PMRA 2545410)        |
| Earthworm<br><i>Allolobophora icterica</i>  | Weight loss, burrowing behaviour tests: 0, 0.5, 1.0 mg a.i./kg soil                                                                                                         | Avoidance                                                                                                                                  | No avoidance was observed                                                                                                                                 |                                                                          |
| Earthworm<br><i>Aporrectodea nocturna</i>   | Confidor (200 g a.i./L); 1 month                                                                                                                                            | Burrowing behaviour: (burrow length (m), number of burrows, sinuosity (degrees), verticality (degrees), branching rate, surface casts (g)) | <i>A. nocturna</i> : NOEC = 0.1                                                                                                                           | Capowiez <i>et al.</i> 2006 (PMRA 2574032); WIA 2014a (PMRA 2545410)     |
| Earthworm<br><i>Allolobophora icterica</i>  |                                                                                                                                                                             |                                                                                                                                            | <i>A. icterica</i> : NOEC < 0.1                                                                                                                           |                                                                          |
| Earthworm<br><i>Aporrectodea caliginosa</i> | Imidacloprid (purity not reported)<br><i>A. caliginosa</i> : 0, 0.2, 0.66 and 2 mg a.i./kg soil dw.<br><br><i>L. terrestris</i> : 0, 0.2, 0.66, 2 and 4 mg a.i./kg soil dw. | Burrowing behaviour: burrow length and depth after 1, 7 and 14 days.                                                                       | 1 day exposure:<br>96-h NOEC = 2<br><br>7 day exposure:<br>96-h NOEC = 0.66<br><br>14 day exposure:<br>96-h NOEC < 2 (depth)<br>96-h NOEC = 0.66 (length) | Dittbrenner <i>et al.</i> 2011a (PMRA 2574033); WIA 2014a (PMRA 2545410) |
| Earthworm                                   |                                                                                                                                                                             |                                                                                                                                            | 1, 7 and 14 day exposure:                                                                                                                                 |                                                                          |

| Species                                     | Exposure                                                                                                                                                                                 | Endpoint observed                                                       | Value<br>(mg a.i./kg soil dw)                                                                                                                                                                                                              | Reference                                                                   |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <i>Lumbricus terrestris</i>                 |                                                                                                                                                                                          |                                                                         | 96-h NOEC = 4                                                                                                                                                                                                                              |                                                                             |
| Earthworm<br><i>Eisenia foetida</i>         | Imidacloprid (99.9% purity); 14d<br><i>E.foetida</i> and <i>A.caliginosa</i> : 0, 0.2, 0.66 and 2 mg a.i./kg soil dw.<br><i>L.terrestris</i> : 0, 0.2, 0.66, 2 and 4 mg a.i./kg soil dw. | Body mass reduction after 14 days exposure                              | All specimens died after 14 days exposure to 0.66 and 2 mg a.i./kg dw;<br>14-d NOEC = 0.2.<br><br>Reduced body mass: 14-day NOEC < 0.2.<br>Reduced body mass: 14-d NOEC = 0.2                                                              | Dittbrenner <i>et al.</i> 2011b (PMRA 2574034);<br>WIA 2014a (PMRA 2545410) |
| Earthworm<br><i>Aporrectodea caliginosa</i> |                                                                                                                                                                                          |                                                                         | 14-d NOEC = 2.0                                                                                                                                                                                                                            |                                                                             |
| Earthworm<br><i>Lumbricus terrestris</i>    |                                                                                                                                                                                          |                                                                         |                                                                                                                                                                                                                                            |                                                                             |
| Earthworm<br><i>Eisenia foetida</i>         | Imidacloprid (99.9% purity); 14d<br><i>E.foetida</i> and <i>A.caliginosa</i> : 0, 0.2, 0.66 and 2 mg a.i./kg soil dw.<br><i>L.terrestris</i> : 0, 0.66, 2 and 4 mg a.i./kg soil dw.      | Biochemical: changes in heat shock protein level hsp70<br><br>Avoidance | All specimens died after 14 days exposure to 0.66 and 2 mg a.i./kg dw;<br>14-d NOEC < 0.2 (reduced hsp70 and avoidance)<br>14-d NOEC = 0.66 (hsp 70)<br>No avoidance was observed<br>14-d NOEC = 2.0 (hsp 70)<br>No avoidance was observed | Dittbrenner <i>et al.</i> 2012 (PMRA 2574035);<br>WIA 2014a (PMRA 2545410)  |
| Earthworm<br><i>Aporrectodea caliginosa</i> |                                                                                                                                                                                          |                                                                         |                                                                                                                                                                                                                                            |                                                                             |
| Earthworm<br><i>Lumbricus terrestris</i>    |                                                                                                                                                                                          |                                                                         |                                                                                                                                                                                                                                            |                                                                             |
| <b>Chronic</b>                              |                                                                                                                                                                                          |                                                                         |                                                                                                                                                                                                                                            |                                                                             |
| Earthworm                                   | Technical imidacloprid (purity not reported)<br>Confidor SL 200<br>Gaucho WS 600                                                                                                         | NOEC reproduction (study duration not reported)                         | ≥ 0.178<br>≥ 0.562<br>coated on seeds:<br>≥ 585 g a.i./ha                                                                                                                                                                                  | EFSA 2008<br>(PMRA 2332663)                                                 |
| Springtail<br><i>Folsomia candida</i>       | Technical imidacloprid (purity not reported)<br>Confidor SL 200<br>Gaucho FS 600<br>Gaucho FS 600                                                                                        | NOEC reproduction (study duration not reported)                         | 1.25<br>0.32<br>0.20<br>coated on seeds:<br>656 g a.i./ha                                                                                                                                                                                  |                                                                             |
|                                             | Imidacloprid-olefin (M06, purity not reported)<br>Imidacloprid-nitrosimine (M07, purity not reported)<br>Confidor 600FS                                                                  |                                                                         | 10<br>1.0                                                                                                                                                                                                                                  |                                                                             |
|                                             |                                                                                                                                                                                          | 28 day NOEC (based on reduced number of juveniles)                      | <0.6                                                                                                                                                                                                                                       | Alves <i>et al.</i> 2014 PMRA 2535326                                       |
| Earthworm                                   | Merit 2F                                                                                                                                                                                 | Single application:<br>LOEC (inhibited feeding activity)                |                                                                                                                                                                                                                                            | Tu <i>et al.</i> 2011 (PMRA 2535322)                                        |

| Species                                   | Exposure                                                                                                                                                                                                                                                                                  | Endpoint observed                                                                                                                                                                                                                                                                                                                                                                                                                           | Value<br>(mg a.i./kg soil dw)                                                                                                                                                                                                 | Reference                                                                   |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <i>Terrestris lumbricus</i>               | (43 mg/m <sup>2</sup> )                                                                                                                                                                                                                                                                   | 4 applications at 7-day intervals:<br>LOEC (45% mortality)                                                                                                                                                                                                                                                                                                                                                                                  | 43 mg/m <sup>2</sup>                                                                                                                                                                                                          |                                                                             |
| Earthworm<br><i>Eisenia Andrei</i>        | Gaucho 600 FS<br>(600 g a.i./L)                                                                                                                                                                                                                                                           | 28 day exposure period<br>Reduced reproductive rate (no. juveniles):<br>NOEC<br>EC <sub>50</sub><br><br>48-h exposure period<br>Avoidance behaviour:<br>EC <sub>50</sub>                                                                                                                                                                                                                                                                    | <0.75<br>4.07<br><br>0.11                                                                                                                                                                                                     | Alves <i>et al.</i> 2013 (PMRA 2535324).                                    |
| Nematode<br><i>Caenorhabditis elegans</i> | Imidacloprid (98% purity)                                                                                                                                                                                                                                                                 | 48-h EC <sub>50</sub> (no. eggs produced)                                                                                                                                                                                                                                                                                                                                                                                                   | 519 mg a.i./L                                                                                                                                                                                                                 | Gomez-Eyles <i>et al.</i> 2009 (PMRA 2574027);<br>WIA 2014a (PMRA 2545410)  |
| Earthworm<br><i>Eisenia foetida</i>       |                                                                                                                                                                                                                                                                                           | 14-d EC <sub>50</sub> (cocoon production)                                                                                                                                                                                                                                                                                                                                                                                                   | 1.41                                                                                                                                                                                                                          |                                                                             |
|                                           |                                                                                                                                                                                                                                                                                           | 14-d EC <sub>50</sub> (weight change)                                                                                                                                                                                                                                                                                                                                                                                                       | 2.77                                                                                                                                                                                                                          |                                                                             |
|                                           |                                                                                                                                                                                                                                                                                           | 14-d EC <sub>50</sub> (manure eaten)<br>14-d NOEC (for all endpoints)                                                                                                                                                                                                                                                                                                                                                                       | 1.88<br>0.745                                                                                                                                                                                                                 |                                                                             |
| Earthworm<br><i>Eisenia foetida</i>       | Merit Solupak (750 g a.i.WP)<br><br>35 day exposure: treated leaf litter at 0, 1.4, 15, 25 and 45 mg/kg fresh weight                                                                                                                                                                      | Survival<br>Weight loss                                                                                                                                                                                                                                                                                                                                                                                                                     | LC <sub>50</sub> = 25 mg/kg<br>NOEC = 1.4 mg/kg<br><br>Results reported based on nominal test concentrations and fresh weight of leaf litter. Average recovery of imidacloprid from QC leaf litter samples was 85.3% (n = 8). | Kreutzweiser <i>et al.</i> 2008 (PMRA 2574028);<br>WIA 2014a (PMRA 2545410) |
| Earthworm<br><i>Dendrobaena octaedra</i>  | Merit Solupak (750 g a.i.WP)<br><br>35 day exposure: treated leaf litter at 0, 3, 7, 14, 28 and 56 mg/kg fresh weight                                                                                                                                                                     | Survival<br>Weight loss<br>Leaf consumption/decomposition<br>Cocoon production                                                                                                                                                                                                                                                                                                                                                              | LC <sub>50</sub> = 5.7 mg/kg<br>NOEC < 3 mg/kg<br>NOEC = 3 mg/kg<br>NOEC = 3 mg/kg<br><br>In separate experiment, no effects on microbial decomposition of leaf material at > 1400 mg/kg.                                     |                                                                             |
|                                           | Imidacloprid (emulsifiable formulation – 50 mg a.i./mL).<br><br>Tree injection: Exposure to leaves collected at senescence from untreated (control) and treated maple sugar trees (25g/m dbh):<br>“low field” (Fall – 6cm dbh)<br>“high field” (June – 15cm dbh)<br>“overdose” (6 cm dbh) | <i>D. Octaedra</i> exposed to leaves in microcosm experiments.<br><br>Mortality, body weight, reproduction (# of cocoons); observations weekly up to 35 days. Cocoons were removed at weekly interval and held in experimental lab for 6 weeks beyond the end of the experiment. The number of juveniles hatched from cocoons was determined.<br><br>Results: Concentration in leaf litter (fresh weight):<br>“low field” – 1.4 – 5.4 mg/kg |                                                                                                                                                                                                                               |                                                                             |



| Species                            | Exposure                                                                                                                                                                                                                                                           | Endpoint observed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Value<br>(mg a.i./kg soil dw)                                   | Reference                                                         |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------|
|                                    |                                                                                                                                                                                                                                                                    | <p>"high field" - 6.4 – 18.5 mg/kg<br/>"overdose" - 86 – 188 mg/kg</p> <p>No mortality in control or any of the treatment groups. Significant weight loss observed in earthworms exposed to "overdose" treatment group. No significant differences among treatments in the number of cocoons produced or in the percentage of cocoons hatched.</p>                                                                                                                                                                                                                                                                     |                                                                 |                                                                   |
|                                    | <p>Imidacloprid (emulsifiable formulation - 50 mg a.i./mL).</p> <p>Tree injection (August): Exposure to leaves collected at senescence from untreated (control) and treated maple sugar trees.<br/>"low dose" - 0.125 g/cm dbh<br/>"high dose" - 0.25 g/cm dbh</p> | <p><i>D. Octaedra</i> exposed to leaves in microcosm experiments.</p> <p>Mortality, leaf decomposition measured as mass loss; observations weekly up to 35 days.</p> <p>Results: Survival of earthworms may have been affected by the imidacloprid in leaves, but the response was not dose dependent with 3 of 10 dead in low-dose, and 1 of 10 dead in high-dose microcosms and only by day 35. Mass loss of leaf material was significantly lower in treatment microcosms than in controls.</p>                                                                                                                     |                                                                 | Kreutzweiser et al. 2009 (PMRA 2541838); WIA 2014a (PMRA 2545410) |
| <b>Field studies</b>               |                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                 |                                                                   |
| Earthworms                         | Confidor WG 70<br>(applied once a year for 6 years)                                                                                                                                                                                                                | NOEC: Abundance of the natural earthworm population                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 150 g a.i./ha                                                   | EFSA 2008<br>(PMRA 2332663)                                       |
|                                    | Imidacloprid applied as seed treatment (Zelmone 350FS once a year for 6 years as sowing of winter barley seeds)                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ≥ 133 g a.i./ha                                                 |                                                                   |
|                                    | <p>Fall application:</p> <p>Merit 75 wettable powder (450 g a.i./ha - spray irrigation) and,</p> <p>Merit 0.5G (340 g a.i./ha - drop spreader + irrigation)</p> <p>Spring application</p> <p>Merit 0.5G (340 g a.i./ha - drop spreader + irrigation)</p>           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Transient effect: Recovery within 36 – 40 days post application | USDA 2005<br>PMRA (2334762)                                       |
| Surface and soil-active arthropods | Merit 0.5G (370 g a.i./ha - applied to turf by drop spreader once a year for 6 years).                                                                                                                                                                             | Abundance measures monthly (July – October). No discernable effect relative to control turf on abundance of surface-active fauna over 6 years of consecutive use. Decreased abundance of soil-dwelling fauna (for example, hemiptera, thysanoptera, Coleoptera and Collembola. Abundance was also suppressed in adult beetles (not larvae) of Carabidae and Staphylinidae but not Chrysomelida or Curculionidae. Some species were suppressed all season long and never recovered over the 5 years while others recovered by the next season. Only a single test concentration was tested; the NOEC is ~370 g a.i./ha. |                                                                 | Peck 2009a; PMRA 2541664                                          |
| Soil-active arthropods             | Merit 0.5G (370 g a.i./ha - applied to turf by drop spreader once a year for 3 years).                                                                                                                                                                             | A consistent short-term effect due to individual applications was not detected. However, when data were examined across both seasons, a significant cumulative effect of treatment was detected for total hexapods, Collembola,                                                                                                                                                                                                                                                                                                                                                                                        |                                                                 | Peck 2009b; PMRA 2541666                                          |

| Species | Exposure | Endpoint observed                                                                                                                                                                                                                                                  | Value<br>(mg a.i./kg soil dw) | Reference |
|---------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------|
|         |          | Thysanoptera and Coleoptera adults, but not oribatid mites, non-oribatid mites, Hymenoptera, Hemiptera, Coleoptera larvae or Diptera. These taxonomic groups were suppressed by 54 – 62%. Only a single test concentration was tested; the NOEC is <370 g a.i./ha. |                               |           |

Table 3 Summary of acute and chronic toxicity endpoints reported for beneficial arthropods

| Species                                         | Test substance/application rate                     | Endpoint observed | Value                                             | Reference                   |
|-------------------------------------------------|-----------------------------------------------------|-------------------|---------------------------------------------------|-----------------------------|
| Laboratory tests                                |                                                     |                   |                                                   |                             |
| <i>Typhlodromus pyri</i><br>Predatory mite      | Confidor SL200                                      | mortality         | LR <sub>50</sub> = 4.23 g a.i./ha (proto-nymphs)  | EFSA 2008<br>(PMRA 2332663) |
| Parasitic wasp <i>Aphidius rhopalosiphii</i>    |                                                     |                   | LR <sub>50</sub> = 0.022 g a.i./ha (adults)       |                             |
| Extended laboratory tests                       |                                                     |                   |                                                   |                             |
| <i>Typhlodromus pyri</i><br>Predatory mite      | Confidor 200SL<br>(on apple leaves)                 | Mortality         | LR <sub>50</sub> = 19.13 g a.i./ha (proto-nymphs) | EFSA 2008<br>(PMRA 2332663) |
|                                                 | Confidor 200SL<br>(on apple leaves; 0.32 g a.i./ha) | Reproduction      | No effects (0%) (adults)                          |                             |
| <i>Aphidius rhopalosiphii</i><br>Parasitic wasp | Confidor 200SL<br>(on apple leaves)                 | Mortality         | LR <sub>50</sub> = 0.45 g a.i./ha (adults)        |                             |
|                                                 | Confidor 200SL<br>(on apple leaves; 0.32 g a.i./ha) | Reproduction      | No reduction (-11%)                               |                             |
| <i>Coccinella septempunctata</i>                | Confidor 200SL<br>(on apple leaves)                 | Mortality         | LR <sub>50</sub> = 11.38 g a.i./ha (adults)       |                             |
|                                                 | Confidor 200SL<br>(on apple leaves; 4.7 g a.i./ha)  | Reproduction      | No reduction (-16%) (adults)                      |                             |

| Species                                  | Test substance/application rate                                              | Endpoint observed | Value                                                                    | Reference |
|------------------------------------------|------------------------------------------------------------------------------|-------------------|--------------------------------------------------------------------------|-----------|
| <i>Chrysoperla carnea</i> Green lacewing | Confidor 200SL (on apple leaves)                                             | Mortality         | LR <sub>50</sub> = 10.51 g a.i./ha (larvae)                              |           |
|                                          | Confidor 200SL (on apple leaves; 25 g a.i./ha)                               | Reproduction      | 32%                                                                      |           |
| <i>Poecilus cupreus</i> Ground beetle    | Confidor 200SL (on soil)                                                     | Mortality         | LR <sub>50</sub> = 497 g a.i./ha; (adults)                               |           |
|                                          | Confidor 200SL (on soil; 330 g a.i./ha)                                      | Feeding rate      | 30% inhibition; (adults)                                                 |           |
|                                          | Imidacloprid<br>mg a.i./kg soil<br>0.04<br>0.4<br>4                          | Mortality         | Larvae<br>0%<br>100%<br>100%                                             |           |
|                                          | Imidacloprid<br>mg a.i./kg soil<br>0.01<br>0.1                               | Mortality         | Larvae<br>0%<br>40.5%                                                    |           |
|                                          | Imidacloprid                                                                 | Mortality         | LR <sub>50</sub> = 0.136 mg a.i./kg soil                                 |           |
|                                          | Imidacloprid<br>mg a.i./kg soil<br>0.015<br>0.020<br>0.025<br>0.030<br>0.035 | Mortality         | Larvae<br>5%<br>10%<br>15%<br>10%<br>0%                                  |           |
|                                          | Confidor WG 70<br>mg a.i./kg soil<br>0.029<br>0.059<br>0.116                 | Mortality         | Larvae<br>32%<br>56%<br>79%                                              |           |
|                                          | Gaucho FS 350 on wheat seeds                                                 | Mortality         | 77.8% at seeds coated with 200ml/dt; drilled at 200 kg/ha; (adults)      |           |
|                                          | Gaucho WS70 (sugar beet seeds)                                               | Mortality         | 80.6% at seeds coated with 90 g a.i./l; drilled at 25 l/ha               |           |
|                                          |                                                                              | Mortality         | 30% at 14 seeds/m <sup>2</sup>                                           |           |
|                                          |                                                                              |                   | 10% at 40 seeds/m <sup>2</sup>                                           |           |
| <i>Aleochara bilineata</i>               | Gaucho WS70 (sugar beet seeds)                                               | Reproduction      | 101% offspring at seeds coated 90 g a.i./l; drilled at 10.5 l/ha; adults |           |
| <i>Pardosa</i> spp.                      | Gaucho FS 600 (corn seeds)                                                   | Mortality         | 4.2%                                                                     |           |
|                                          |                                                                              | Feeding rate      | 2.5%                                                                     |           |

| Species                                                    | Test substance/application rate                                                                                       | Endpoint observed                                  | Value                                                                                                                                                                                                                                                                          | Reference                   |
|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Predatory soil dwelling mite<br><i>Hypoaspis aculeifer</i> | Technical imidacloprid<br>(purity not reported)                                                                       | NOEC reproduction<br>(study duration not reported) | 2.67 mg a.i./kg soil dw                                                                                                                                                                                                                                                        |                             |
| Extended laboratory tests (aged residues)                  |                                                                                                                       |                                                    |                                                                                                                                                                                                                                                                                |                             |
| <i>Typhlodromus pyri</i><br>Predatory mite                 | Confidor SL200 on apple leaves<br>(2 × 100 g a.i./ha, 14 day interval)                                                | Mortality                                          | 7 days – 33%; (proto-nymphs)                                                                                                                                                                                                                                                   | EFSA 2008<br>(PMRA 2332663) |
|                                                            |                                                                                                                       | reproduction                                       | 21 days – 5% reduced (proto-nymphs)                                                                                                                                                                                                                                            |                             |
| <i>Aphidius rhopalosiphu</i><br>Parasitic wasp             | Confidor SL200 on apple leaves<br>(2 × 100 g a.i./ha, 14 day interval)                                                | Mortality                                          | 7 days – 0%; (adults)                                                                                                                                                                                                                                                          |                             |
|                                                            |                                                                                                                       | reproduction                                       | 14 days – (-13%); (adults)                                                                                                                                                                                                                                                     |                             |
| <i>Aphidius rhopalosiphu</i><br>Parasitic wasp             | Confidor SL200 on tomato leaves<br>(2 × 100 g a.i./ha, 14 day interval)                                               | mortality                                          | 0 days – 83 %; (adults)<br>7 days – 54 %<br>14 days – 54 %<br>21 days – 3 %                                                                                                                                                                                                    |                             |
|                                                            |                                                                                                                       | reproduction                                       | 14 days – 54 %; (adults)<br>21 days – (-28 %)                                                                                                                                                                                                                                  |                             |
| <i>Poecilus cupreus</i><br>Ground beetle                   | Gaucho FS350 on soil                                                                                                  | mortality<br>(aged residue concentration)          | after 247 d aging:<br>0.03 mg as/kg – 11 %<br>0.06 mg as/kg – (-5.6%)<br>0.13 mg as/kg – 0 %<br>0.25 mg as/kg – 0 %<br>0.5 mg as/kg – 5.6 %<br>Aging of 247 days is not considered as a timeframe that suggests recovery of a population within an ecologically relevant time. |                             |
| Toxicity data reported by USDA 2005                        |                                                                                                                       |                                                    |                                                                                                                                                                                                                                                                                |                             |
| Convergent lady beetle<br><i>(Hippodamia a convergens)</i> | Imidacloprid (95% a.i.)<br>(10, 50, 100, 200, 300 and 800 ppm in acetone - topical application)                       | mortality                                          | 24 hour LD <sub>50</sub> = 1.8 µg/g<br>48 hour LD <sub>50</sub> = 0.7 µg/g<br>72 hour LD <sub>50</sub> = 0.4 µg/g<br>(dose based on insect body weight)                                                                                                                        | USDA 2005<br>(PMRA 2334762) |
| Beetle ( <i>Harpalus pennsylvanicus</i> )                  | Not reported                                                                                                          | incapacitation                                     | LOAEC = 0.084 kg a.i./ha, incapacitation within 4 hours, recovery within 4 days for 85% of beetles.                                                                                                                                                                            |                             |
|                                                            | 25%, 50% and 100% 0.336 kg/ha to plots/ spray                                                                         | incapacitation                                     | LOAEC = 0.084 kg a.i./ha, incapacitation within 4 hours, recovery within 4 days for 85% of beetles                                                                                                                                                                             |                             |
|                                                            | Not reported                                                                                                          | incapacitation                                     | LOAEC = 0.084 kg a.i./ha, incapacitation within 4 hours, recovery within 4 days for 85% of beetles                                                                                                                                                                             |                             |
|                                                            | dog pellets sprayed with 25%, 50% and 100% 0.336 kg/ha                                                                | fecundity, timing egg hatching                     | NOAEC = 0.336 kg a.i./ha                                                                                                                                                                                                                                                       |                             |
| Prodacious Mirid bug<br><i>(Hyalodius vitripennis)</i>     | Admire (240 g/L EC): Geometric progression based on label rate of 0.0312 g a.i./L; direct spray to insect/leaves/cage | mortality                                          | 24-h Nymph LC <sub>50</sub> : 0.0023 g a.i./L<br>(95% CI: 0.0018 – 0.0029)<br><br>24-h Adult LC <sub>50</sub> : 0.0011 g a.i./L                                                                                                                                                |                             |



| Species                                                                                     | Test substance/application rate                                                                                                                                                                                 | Endpoint observed | Value                                                                                                                                                                                                                                                                                                                                                                                                     | Reference |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                                                                                             |                                                                                                                                                                                                                 |                   | (95% CI: 0.0008 – 0.0017)<br><br>The difference between adults and nymphs is not statistically significant. The LC <sub>50</sub> values are lower than the label application rates, indicating use of the label application rate in the field would result in 100% mortality of both adult and nymph stages.                                                                                              |           |
| Vedalia beetle<br>( <i>Rodolia cardinalis</i> )                                             | Admire 2F:<br>72-hour exposure to cottony cushion scale larvae raised on plants growing in imidacloprid treated soil (0.15 ml, Admire 2F)                                                                       |                   | LOAEC: significantly reduced mean percentage of adult beetles and progeny with respect to controls on day 22 post-exposure, but not on days 43-155 post-exposure. Significantly reduced number of 2nd instar larvae surviving to adulthood (0 - 24.44% on days 8 - 29 after treatment; 51.11 - 66.67 on days 57 through 141 after treatment); recovery to control percentages on 169 days post-treatment. |           |
| Parasitoid wasp<br>Hymenopteran<br>( <i>Trichogramma nr.</i><br><i>Brassicacae</i> )        | Confidor 350 SC:<br>field application rate = 5.25 g a.i./100 L,<br>singledirect application to adults                                                                                                           | mortality         | 100% mortality after 3 hours                                                                                                                                                                                                                                                                                                                                                                              |           |
|                                                                                             | Confidor 350 SC:<br>potted tomato plants sprayed to runoff at label rate; wasps exposed to leaves 0, 1, 4 and 7 days after spraying.                                                                            | mortality         | mortality LOAEC = 100 g a.i./100L, on day of spray only. No effects on later days. No effects on reproduction/growth. No effects when parasite eggs dipped in formula at 100 g a.i./L.                                                                                                                                                                                                                    |           |
| Phytoseiid mite<br>( <i>Amblyseius victoriensis</i> )                                       | Confidor 350 SC:<br>sprayed on grape leaf discs at field rate to control aphids (5.25 g a.i./100L or 0.0053% a.i.) and 10X this rate                                                                            | mortality         | NOAEC: 0.0525 g a.i./L. (field rate)<br>LOAEC: 0.525 g a.i./L. (10X field rate; 34.4% mortality)                                                                                                                                                                                                                                                                                                          |           |
|                                                                                             | Confidor 350 SC:<br>apricot orchard study. Spray at field rate of 5.25 g                                                                                                                                        | abundance         | LOAEC: significant transient reduction in population 4 weeks after exposure. However, population rebounded to exceed control values 9-12 weeks after exposure.                                                                                                                                                                                                                                            |           |
| Predatory bug<br>( <i>Orius laevigatus</i> )                                                | Confidor 200 SL:<br>72-hour acute ingestion toxicity test with Confidor 200 SL (Imidacloprid a.i.), 8 concentrations                                                                                            | mortality         | Nymph LC <sub>50</sub> : 1.1 mg a.i./L.<br>Adult LC <sub>50</sub> : 2.1 mg a.i./L.                                                                                                                                                                                                                                                                                                                        |           |
|                                                                                             | Confidor 200 SL:<br>72-hour residual contact test with Confidor 200 SL (Imidacloprid a.i.), 5 concentrations                                                                                                    | mortality         | Nymph LC <sub>50</sub> : 0.04 mg a.i./L.<br>Adult LC <sub>50</sub> : 0.3 mg a.i./L.                                                                                                                                                                                                                                                                                                                       |           |
| Predatory bug nymphs<br>( <i>Dicyphus tamaninii</i><br>and <i>Macrolophus caliginosus</i> ) | Confidor 20LS (20% a.i.)<br>0.5 ml/L (maximum Recommended rate)/tomato plants sprayed until runoff; bugs exposed at various intervals after spray (1, 3, 8, 21 and 30 day residues of treated tomato leaflets). | mortality         | LOAEC: <i>D. tamaninii</i> was more sensitive, with mortality ranging from 33.7% 24 hours after exposure to 1-day residues, to 91.9% 7 days after exposure to 1-day residues. Percent mortality declined with increasing residue time, with 2 to 26.0% mortality at 24 hours and 7-days, respectively, after exposure to 30 day residues.                                                                 |           |
| Euonymus scale<br>Parasitoid Hymenopteran<br>( <i>Encarsia citrina</i> )                    | Marathon 60 WP:<br>Soil drench at 0.33g/500 ml water; foliar application at 0.15g/500 ml of water                                                                                                               | infectivity       | No effect on parasitoid infectivity                                                                                                                                                                                                                                                                                                                                                                       |           |
| Predatory arthropods<br>assessed in field study:<br>ants, carabids, spiders, and            | Merit 0.5G:<br>0.336 kg a.i./ha, drop spreader with irrigation; study replicated in 1996 and 1997                                                                                                               | abundance         | LOAEC: reduced the abundance of hister beetles and predatory larvae across all sample dates in 1996 but not in 1997; reduced scavenging rates on fresh-frozen black cutworms during the first week after treatment, but scavenging                                                                                                                                                                        |           |

| Species                                                               | Test substance/application rate                                                                                                                                                                                                              | Endpoint observed                     | Value                                                                                                                                                                                                                                                                                                                                 | Reference |
|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| staphylinids                                                          |                                                                                                                                                                                                                                              |                                       | activity returned to normal with respect to controls 2-4 weeks post-treatment. There was no difference between controls and imidacloprid-treated plots with respect to scavenging of black cutworm eggs or Japanese beetle eggs. Ants were the primary predators.                                                                     |           |
| Predatory ants                                                        | Merit 0.5G:<br>0.34 kg a.i./ha by drop spreader or hand broadcast to plots of turf-grass, with irrigation                                                                                                                                    | abundance                             | NOAEC: abundance of ants and absence of prey (Japanese beetles and white grubs).                                                                                                                                                                                                                                                      |           |
| Parasitoid Ichneumonidae<br>Hymenopteran ( <i>Diadegma insulare</i> ) | Provado 1.6F:<br>leaf discs dipped in solution at various field application rates (0.22 mg a.i./mL, and 0.01, 0.05, 0.1 and 0.5X). Leaves dipped in solution equal to a pray volume of 240 L/ha, insects released to jars with treated leaf. | mortality                             | 24-hour LC <sub>50</sub> : 0.002 mg a.i./ml (equivalent to 0.48 g a.i./ha)                                                                                                                                                                                                                                                            |           |
| Insidious flower bug<br>( <i>Orius insidiosus</i> ; 8 days old)       | Provado 1.6F:<br><i>Helicoverpa zea</i> eggs sprayed at 0.052 kg a.i./ha                                                                                                                                                                     | egg consumption, fecundity, mortality | NOAEC: Egg consumption and fecundity did not differ from control levels.<br>LOAEC: 47.8 and 62.7% mortality after 72-h.                                                                                                                                                                                                               |           |
| Big-eyed bug<br>( <i>Geocoris punctipes</i> ; 8 days old)             | Provado 1.6F:<br><i>Helicoverpa zea</i> eggs sprayed at 0.052 kg a.i./ha                                                                                                                                                                     | egg consumption, mortality            | LOAEC: 11.1 and 50.0% mortality among males and females after 72-h. Egg consumption was significantly less than that of untreated controls.                                                                                                                                                                                           |           |
| Vedalia beetle<br>( <i>Rodolia cardinalis</i> )                       | Provado 1.6F:<br>0.56 kg a.i./ha; soil drench                                                                                                                                                                                                | mortality and reproduction            | 72-hour NOAEC adult survival and reproduction.<br>LOAEC larval survival: all dead within 3 days.                                                                                                                                                                                                                                      |           |
|                                                                       | Provado 1.6F:<br>0.14 kg a.i./ha; foliar spray                                                                                                                                                                                               | mortality                             | 72-hour LOAEC for adult and larval survival: significantly reduced adult survival and progeny per female 26 days after treatment; all larvae died within 8 days of exposure to treated foliage.                                                                                                                                       |           |
|                                                                       | Provado 1.6F:<br>72-hour exposure to cottony cushion scale larvae raised on plants sprayed to runoff with 0.2 ml Provado 1.6F                                                                                                                | abundance                             | LOAEC: significantly reduced mean percentage of adult beetles and progeny with respect to controls on day 20 and 41 post-exposure, but not thereafter up to day 182. Significantly reduced percentage of larvae reaching adulthood for beetles exposed to treated scale insects and leaves on days 6 through 27 after treatment only. |           |
| Ectoparasitoid<br>Hymenopteran<br>( <i>Colpochypeus florus</i> )      | Provado 2F:<br>"48 ppm or amount/100 gallons"/ direct spray (100% application rate for controlling leafhopper in apple trees) and exposure to residues                                                                                       | mortality                             | LOAEC: 86% mortality in 48-hours following direct spray; no mortality if insects are exposed to leaves after they are sprayed.                                                                                                                                                                                                        |           |
| Ectoparasitoid<br>Hymenopteran<br>( <i>Trichogramma platneri</i> )    | Provado 2F:<br>48 ppm or amount/100 gallons"/ direct spray (100% application rate for controlling leafhopper in apple trees)                                                                                                                 | mortality                             | 100% mortality in 48 hours                                                                                                                                                                                                                                                                                                            |           |

| Species                                             | Test substance/application rate                                                                                                                                                                                                                                                                                                 | Endpoint observed                                                                                                                                             | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Reference                                 |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| Open literature                                     |                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                           |
| Predatory beetle<br><i>Cybocephalus nipponicus</i>  | Imidacloprid (Provado, 99% purity); similar to glass plate method at 0, 0.5X, 1X (2.4 µg a.i./cm <sup>2</sup> ) and 2X field application rate; equivalent to 0, 120, 240 and 480 g a.i./ha.                                                                                                                                     | Mortality                                                                                                                                                     | After 24 h:<br>Control – 0%<br>120 g/ha – 76%<br>240 g/ha – 93%<br>480 g/ha – 100%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Smith and Cave 2006; PMRA 2541662         |
| Predatory beetle<br><i>Rhyzobius yasumatsui</i>     |                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               | After 24h:<br>Control – 0%<br>120 g/ha – 63%<br>240 g/ha – 80%<br>480 g/ha – 100%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                           |
| Isopod<br><i>Porcellio scaber</i>                   | Imidacloprid (99.8% purity); 2 week exposure to treated food; adults at 0, 10 and 25 µg a.i./g dry food; juveniles at 0, 2.5, 5, 10 and 25 µg a.i./g dry food.                                                                                                                                                                  | Mortality, weight loss, feeding rate<br><br>Glutathione S-transferase activity (GST), total protein<br><br>Digestive gland epithelial thickness – adults only | Juveniles NOEC (µg a.i./g dry food)<br>>50 (mortality)<br>5 (weight loss)<br>10 (decreased feeding rate; 0.5 µg/g bw/day)<br><br>Adults<br>>25 (mortality)<br>>25 (weight loss)<br><10 (decreased feeding rate; -0.24 µg/g bw/day)<br><br>In juveniles, induction of GST activity and increase of total protein content per wet animal weight was detected at 5 µg/g dry food, whereas in adults a reduction of GST was observed at 25 µg/g (NOEC 10 µg/g). A decrease in adult digestive epithelial thickness was observed at < 10 µg/g (NOEC).                              | Drobne <i>et al.</i> 2008, (PMRA 2545406) |
| Ladybird beetle<br><i>Coccinella septempunctata</i> | Imidacloprid (97.3% purity)<br><br>Microcosm toxicity test : full life cycle – 30 days (2 <sup>nd</sup> instar larvae)<br><br>Single application: 0, 0.85, 1.71, 3.42, 6.83 and 13.66 g a.i./ha.<br><br>A preliminary acute toxicity test (2 <sup>nd</sup> instar larvae) was also conducted; exposure conditions not reported. | Development period, pupation percentage, hatching percentage, adult emergence, mortality and egg production                                                   | Preliminary acute toxicity test:<br>72-h I.R. <sub>50</sub> = 683.2 g a.i./ha<br><br>Long term toxicity test:<br>72-h I.R. <sub>50</sub> = 5.53 g a.i./ha<br><br>E.R. <sub>50</sub> = 26.63 g a.i./ha (egg production)<br>NOER = 6.83 g a.i./ha (egg hatching)<br><br>NOER ≥ 13.66 g a.i./ha (development duration, pupation and adult emergence)<br><br>The study lacks detail regarding acute and long-term experimental conditions that would explain the 100 fold difference in the 72-h I.R. <sub>50</sub> values. The study results should be interpreted with caution. | Yu <i>et al.</i> 2014; PMRA 2535330       |
| Parasitic wasp<br><i>Trichogramma cacoeciae</i>     | Imidacloprid (Confidor 200SL)<br><br>Acute adult toxicity test (glass plate – 13 × 13 cm): 0, 4, 5, 7, 10, 15, 21 mg/L nominal.                                                                                                                                                                                                 | Adult mortality                                                                                                                                               | Acute toxicity:<br>I.R. <sub>50</sub> = 6.25 mg/L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Saber 2011; PMRA 2535329                  |

| Species                                                                                                                        | Test substance/application rate                                                                                                                                                                                                                             | Endpoint observed                                                                                                                                         | Value                                                                                                                                                                                                                                                                                                                                                                      | Reference                                                         |
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|                                                                                                                                | Development toxicity test: Development of <i>T. cacoeciae</i> parasitized eggs treated with 0 and 350 mg/L nominal at three pre-imaginal developmental stages (larvae).                                                                                     | Percent emergence, Population parameters (longevity, progeny production of emerged adults, generation time, intrinsic rate of increase and doubling time) | Developmental toxicity: (350 mg/L exposure)<br>11% reduced emergence<br>Population parameters were not affected.<br><br>There is uncertainty as to whether endpoints are reported based on formulated product or a.i.                                                                                                                                                      |                                                                   |
| Green lacewing <i>Chrysoperla carnea</i>                                                                                       | Imidacloprid (purity not reported); 0, 0.17, 0.28 and 0.56 ml/l.<br><br>Three experiments:<br>1) Toxicity to eggs<br>2) Larval toxicity (2 <sup>nd</sup> instars) dietary exposure and glass plate<br>3) Adult toxicity (dietary exposure)                  | Experiment:<br>1) Percent hatchability<br>2) Mortality, emergence<br>3) Mortality                                                                         | The results are reported in terms of ml/L imidacloprid product; nor is the purity of the product reported. A suitable endpoint cannot be derived from the study results.                                                                                                                                                                                                   | Preetha <i>et al.</i> 2009; PMRA 2535328                          |
| <i>Drosophila melanogaster</i>                                                                                                 | Imidacloprid (99.5% purity)<br><br>Acute tests: 10 nominal concentrations (7.8uM – 3.1 mM); larvae<br><br>Chronic tests: (1.5 g a.i. in 4.5 mL)                                                                                                             | Acute survival                                                                                                                                            | Mating and fecundity tests were also conducted. The endpoints are reported in terms of uM or nM; these units are not amenable to the risk assessment.                                                                                                                                                                                                                      | Charpentier <i>et al.</i> 2014; PMRA 2541663                      |
| <i>Drosophila melanogaster</i>                                                                                                 | Imidacloprid (96.4% purity)<br><br>Acute tests: larvae and adult exposures (0.05 – 15 mg a.i./g diet)<br><br>Three strains of <i>D. melanogaster</i> were tested: Canton-S, w <sup>1118</sup> and Oregon.                                                   | Larvae mortality: adult emergence<br><br>Adults: 24-h mortality                                                                                           | Canton-S:<br>Larvae LD <sub>50</sub> = 0.41 µg/g<br>Adult LD <sub>50</sub> = 4.58 µg/g<br><br>w <sup>1118</sup> :<br>Larvae LD <sub>50</sub> = 1.39 µg/g<br>Adult LD <sub>50</sub> = 4.57 µg/g<br><br>Oregon:<br>Larvae LD <sub>50</sub> = 0.81 µg/g<br>Adult LD <sub>50</sub> = 4.12 µg/g                                                                                 | Arain <i>et al.</i> 2014 (PMRA 2574024); WIA 2014a (PMRA 2545410) |
| Glassy-winged sharpshooter <i>Homalodisca vitripennis</i><br><br>Fairyfly (mymarid egg parasitoid) <i>Gonatocerus ashmeadi</i> | Imidacloprid (purity not reported)<br><br><i>H. vitripennis</i> eggs ovipositioned onto treated cotton leaves (0, 0.1, 1.0 and 10 mg a.i./L).<br><br><i>H. vitripennis</i> eggs parasitized by <i>G. ashmeadi</i> , ovipositioned on treated cotton leaves. | Mortality 48 h after emergence.                                                                                                                           | There was no mortality to the developing embryos of <i>H. vitripennis</i> or <i>G. ashmeadi</i> .<br><br>Mortality 48 hours after emergence<br><br><i>H. vitripennis</i> : LD <sub>50</sub> = 39 ng/cm <sup>2</sup> (leaf area; equivalent to 390 g a.i./ha)<br><br><i>G. ashmeadi</i> : LD <sub>50</sub> = 66 ng/cm <sup>2</sup> (leaf area; equivalent to 660 g a.i./ha) | Byrne and Toscano 2007 (PMRA 2574025); WIA 2014a (PMRA 2545410)   |



| Species                                                                              | Test substance/application rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Endpoint observed                                                                                                                             | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Reference                                                             |
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|                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                               | (Unit conversion to g a.i./ha reviewer calculated)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                       |
| Asian lady beetles<br><i>Harmonia axyridis</i><br>(Coleoptera: Coccinellidae)        | Confidor WP (purity not reported): exposure rates not reported.<br><br>Instars and adult stage: treated topically with 1 µL on ventral abdomen with microapplicator. Egg hatches and pupae were dipped for 10s, followed by cleaning with filter paper. 3 <sup>rd</sup> and 4 <sup>th</sup> instar, pupae, and adults were treated for 48 h after molting, pupating, and emergence.<br><br><u>Endpoints:</u> Mortality was determined 48 h after treatment for the mobile stages (48-h LC <sub>50</sub> ); hatching of eggs after 1 week; pupae reaching adulthood after 1 week. |                                                                                                                                               | <u>LC<sub>50</sub>s (mg a.i./L)</u><br>Eggs, 1 <sup>st</sup> and 2 <sup>nd</sup> instars: <8.79<br>3 <sup>rd</sup> instars: 30.3<br>4 <sup>th</sup> instars: 190.2<br>Pupae: >1000<br>Adults: 364.1<br><br>Exposure rates were not provided in study. Suitable endpoints cannot be derived from the study results; the toxicity units (mg a.i./L) are not amenable for use to the risk assessment.                                                                                                                                                                               | Youn <i>et al.</i> 2003; PMRA 2574045; WIA 2014a (PMRA 2545410)       |
| Predatory coccinellid<br><i>Hippodamia undecimnotata</i> (Coleoptera: Coccinellidae) | Confidor 20SC (purity not reported)<br><br><u>Exposure:</u> Bean plants ( <i>V. faba</i> ) treated at 0.0355 mg a.i./pot; based on the label rate per ha, the doses that were used were 14 times lower than recommended. 20 aphids ( <i>A. fabae</i> ) were placed on each plant. After 10-15 days, newly hatched <i>H. undecimnotata</i> larvae were placed on plants colonized with aphids.<br><u>Endpoints:</u> immature survival, emergence, sex ratio, fecundity, egg hatchability, adult longevity.                                                                        |                                                                                                                                               | <u>Survival (larvae and pupae):</u> 52% treatment, 77% control.<br>No effect on total immature development time.<br><br><u>Adult fecundity:</u> 33% reduction<br>No significant effect on egg hatchability; reduction in adult longevity; no effect on sex ratio.<br><br>The results are not amenable for use in the risk assessment because only one exposure concentration was used.                                                                                                                                                                                           | Papachristos and Milonas 2008 (PMRA 2574041) WIA 2014a (PMRA 2545410) |
| Green lacewing<br><i>Chrysoperla carnea</i>                                          | Marathon 1% G<br><br><u>Exposure:</u> Flowering plants ( <i>Fagopyrum esculentum</i> and <i>A. curassavica</i> ); soil surface application (6 g, 1x label rate and 12 g, 2x label rate) at 3 weeks prior to <i>C. carnea</i> feeding.                                                                                                                                                                                                                                                                                                                                            | Adult survival and trembling at 1 and 10 days of exposure.<br><br>(Trembling - defined as inability to fly or turn over when placed on back.) | <u>Survival</u><br>Day 1: 95 and 97% at 1x and 2x label rate<br>Day 10: 14 and 6% survival at 1x and 2x label rate<br><br>Trembling was observed in imidacloprid treatments, but not controls. <i>C. carnea</i> were shown to be feeding equally from all treatments, confirming that lacewings were not starving to avoid feeding on treated flowers.<br><br>Only two test concentrations were used; imidacloprid in nectar was not measured. The exposure rate applied to soil (i.e., g a.i./ha) is not reported. The results are not amenable for use in the risk assessment. | Rogers <i>et al.</i> 2007 (PMRA 2574042); WIA 2014a (PMRA 2545410)    |
| Parasitoid wasp<br><i>Microplitis croceipes</i><br>Cresson (Hymenoptera: Braconidae) | Provado (Purity not reported)<br><br><u>Exposure:</u> Feeding on extrafloral nectar from cotton plants treated with 1 mL/L solution = 5 mL per plant; rate recommended by manufacturer.                                                                                                                                                                                                                                                                                                                                                                                          | Foraging ability (measured as flight response in a wind tunnel); longevity.<br><br>Only female adults tested.                                 | <u>Flight response:</u> On day 2, flight response was 23.7% in treatment group and 79.2% in control group. Flight response remained significantly reduced relative to the control group up to 4 days after treatment.<br><u>Longevity:</u> Reduced between 4 to 10 days after treatment compared to control wasps.<br><br>Only one exposure rate was tested. It is unclear whether concentration units are expressed in terms of active ingredient or formulation; the product guarantee is not reported. The results are not amenable for risk assessment use.                  | Stapel <i>et al.</i> 2000 (PMRA 2574044); WIA 2014a (PMRA 2545410)    |

| Species                                                                                                    | Test substance/application rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Endpoint observed                                                                                                                                                                  | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Reference                                                         |
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| Aphid parasitoid<br><i>Aphis ervi</i><br><br>Pea aphid<br><i>Acyrtosiphon pisum</i><br>(Harris)            | Provado 1.6 Flowable<br>(17.4% a.i.)<br><br>Two experiments:<br>1) <i>A. ervi</i> exposed via feeding on pea aphids ( <i>Acyrtosiphon pisum</i> (Harris)) in treated potted broad bean plants ( <i>Vicia faba</i> L.)<br>2) Pea aphids feeding on treated broad bean plants.<br><br>Application to potted plant soil at 0, 4 and 40 g a.i./ha in both experiments.                                                                                                                                | <i>A. ervi</i> population growth rate (measured as emergence of adults) after 14 days feeding on pea aphids.<br><br>Pea aphids population growth (number of aphids) after 14 days. | <i>A. ervi</i> : No effect on population growth rate at highest test concentration (NOEC $\geq$ 40 g a.i./ha).<br><br>Pea aphid population growth rate was reduced at 40 g a.i./ha (NOEC = 4 g a.i./ha).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Kramarz and Stark 2003 (PMRA 2574037); WIA 2014a (PMRA 2545410)   |
| <i>Drosophila melanogaster</i>                                                                             | Imidacloprid (99.9% purity)<br><br>Larvae and adult acute and chronic exposure experiments                                                                                                                                                                                                                                                                                                                                                                                                        | Mortality                                                                                                                                                                          | <u>Larvae:</u><br>Acute 18-h LC <sub>50</sub> : $7.59 \times 10^{-5}$ M (equiv. 19 mg/L)<br>Chronic LC <sub>50(chronic)</sub> : $2.67 \times 10^{-5}$ M (equiv. 6.8 mg/L)<br><br><u>Adult:</u><br>Acute 18-h LC <sub>50</sub> : $1.43 \times 10^{-4}$ M (equiv. 36.5 mg/L)<br>Chronic 8-d LC <sub>50</sub> : $6.09 \times 10^{-5}$ M (equiv. 15.6 mg/L)<br><br>Acute and chronic genotoxicity tests were also conducted; no mutagenic or recombinogenic activity was observed. The range of test concentrations used in toxicity experiments is not reported.                                                                                                                                                                                                                                                                                     | Frantzios <i>et al.</i> 2008; PMRA 2574026; WIA 2014a             |
| 12 spotted lady beetle<br><i>Coleomegilla maculata lengi</i><br>Timberlake (Coleoptera :<br>Coccinellidae) | Imidacloprid<br>(Admire 240 FS; 240 g a.i./L)<br><br>Adult and 3 <sup>rd</sup> instar toxicity assays:<br>1) Topical application – 1 µg solution applied to ventral side at 0, 0.01, 0.1, 1 and 10x the recommended application rate.<br>2) Treated foliage and prey – potato leaflet holding Colorado potato beetle egg mass treated at 0, 0.001, 0.01, 0.1, 1 and 10x the recommended application rate.<br>Application rates above are equivalent to 0, 0.048, 0.48, 4.8, 48 and 480 g a.i./ha. | Mortality at day 2 and 6 after treatment.                                                                                                                                          | <u>Topical ventral application:</u><br>Adult 2-d LC <sub>50</sub> = 0.074 µg a.i./insect<br>Adult 6-d LC <sub>50</sub> = 0.013 µg a.i./insect<br>3 <sup>rd</sup> instar 2-d LC <sub>50</sub> = 0.034 µg a.i./insect<br>3 <sup>rd</sup> instar 6-d LC <sub>50</sub> = 0.008 µg a.i./insect<br><br><u>Foliage and treated prey:</u><br>Adult 2-d LC <sub>50</sub> = 60.8 mg a.i./L<br>Adult 6-d LC <sub>50</sub> = 12.8 mg a.i./L<br>3 <sup>rd</sup> instar 2-d LC <sub>50</sub> = 14.4 mg a.i./L<br>3 <sup>rd</sup> instar 6-d LC <sub>50</sub> = 3.2 mg a.i./L<br><br>The authors report that the LD <sub>50</sub> values at 6 days following treatment, (for adults and 3 <sup>rd</sup> instar exposed to treated foliage and prey), corresponded to 0.02 – 0.09 times the recommended field concentration; equivalent to 0.96 – 4.32 g a.i./ha. | Lucas <i>et al.</i> 2004 (PMRA 2574039); WIA 2014a (PMRA 2545410) |

| Species                                                                                                                                                                                                                | Test substance/application rate                                                                                                                                                                                                                                                                                                                                                                                               | Endpoint observed                                                                                                                        | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Reference                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Ground beetle<br><i>Harpalus pennsylvanicus</i><br>(Coleoptera : Carabidae)                                                                                                                                            | 1) Contact – application to turf (control, 336 g a.i./ha)<br><br>2) Dietary – treated food pellets (control, 168, 336 g a.i./ha)<br><br>3) Residues – treated turf (no irrigation – residues allowed to dry for 1h); treated turf (irrigation – turf watered for 30 min. after treatment). Treatments: control, 336 g a.i./ha                                                                                                 | Adult survival, behaviour, fecundity                                                                                                     | Exposure via contact and dietary route resulted in sublethal effects (i.e., neurotoxicity including paralysis, impaired walking and excessive grooming). Recovery occurred within a few days in the lab; in the field, beetles were shown to be highly vulnerable to ant predation. Female fecundity and viability of eggs was not affected. No behavioural avoidance of residues on treated food was observed. Exposure to dry imidacloprid residues on turfgrass resulted in some intoxication; these effects were reduced by post-treatment irrigation.<br><br>The study design does not follow a dose-response method; a suitable NOEC cannot be derived from the study results.                                                                                                                                                                                                                                                    | Kunkel <i>et al.</i> 2001 (PMRA 2574050); WIA 2014a (PMRA 2545410)     |
| Earthworms on soil arthropods                                                                                                                                                                                          | 1) Spring and fall trials. Turf application, two different formulations at selected rates (Merit 75WP; 340 g a.i./ha and 450 g a.i./ha, 5G; 340 g a.i./ha). Trials done in the spring and fall. Fall application followed by 1.5 cm irrigation.<br><br>2) Turf application (Merit 0.5G, 336 g a.i./ha) granules applied in Spring by drop spreader followed by 1.5 cm irrigation.                                             | 1) Abundance<br><br>2) Predation: black cutworm ( <i>Agrotis ipsilon</i> ) and Japanese beetle ( <i>Popillia japonica</i> ) life stages. | 1) In the fall, only granular formulation (Merit 0.5G) caused short-term (day 9) reduction in earthworm population abundance (39%). All treatments in spring caused significant short-term reduction in abundance. Earthworm population recovery was observed by day 40. Abundance of predatory coleopteran larvae and hister beetles were reduced across all sampling dates; abundance of ants, carabids, spiders and staphylinids was unaffected.<br><br>2) Scavenging of fresh frozen <i>A. ipsilon</i> larvae was reduced – 1 week after treatment; predation on eggs or pupae was unaffected. Predation on transplanted <i>P. japonica</i> eggs was unaffected.<br><br>The study design does not follow a dose-response method; a suitable NOEC cannot be derived from the study results.                                                                                                                                          | Kunkel <i>et al.</i> 1999 (PMRA 2574049); WIA 2014a (PMRA 2545410)     |
| Parasitic wasp<br><i>Anagyrus pseudococci</i><br>(Hymenoptera: Encyrtidae)                                                                                                                                             | Adults exposed via nectar: feeding on buckwheat flowers ( <i>Fagopyrum esculentum</i> ) treated with soil application (Marathon 1%G; control, 1.4 and 2.8 g per pot – 1 and 2x label rate, respectively).<br>A cold anthrone test was conducted to verify that parasitoids were feeding on nectar and not dying from starvation by repellency of nectar. Residue analysis of nectar was conducted (composite of 425 flowers). | Adult survivorship, behaviour (observations made every 12h for 2d followed by every 23 h for 7d).                                        | Parasitoids at 1 d had significantly reduced survivorship of 38% on label rate and 17% on twice label rate compared with 98% on untreated flowers. Parasitoids trembled 88% on label rate and 94% on twice label rate compared with 0% on untreated flowers. Residue analysis showed that imidacloprid concentration was 6.6 ppm (16 ppb/flower) in label rate, 12.3 ppm (29 ppb/flower) in twice label rate, and 0 ppb in untreated flowers. The hydroxy metabolite concentration was 1.1 ppm (2.4 ppb/flower) in label rate, 1.9 ppm (4.4 ppb/flower) in twice label rate, and 0 ppm in untreated flowers. The olefin metabolite concentration was 0.2 ppm (0.5 ppb/flower) in label rate, 0.5 ppm (1.1 ppb/flower) in twice label rate, and 0 ppm in untreated flowers. The study design does not follow a dose-response method; a suitable NOEC cannot be derived from the study results (NOEC <sub>nectar</sub> < 6.6 ppm nectar). | Krischik <i>et al.</i> 2007 (PMRA 2574038); WIA 2014a (PMRA 2545410)4a |
| Parasitic wasps:<br><i>Aphytis melinus</i><br><i>Gonatocerus ashmeidi</i><br><i>Erectmocerus erimicus</i><br><i>Encarsia formosa</i><br><br>Predatory insects:<br><i>Geocoris punctipes</i><br><i>Orius insidiosus</i> | Exposure to systemically treated leaves (Admire, 240 g a.i./L); systemic uptake of Valancia orange terminals with two leaves. A control and at least 5 concentrations were used to obtain mortality that ranged from 5 to 95% for each species.                                                                                                                                                                               | Mortality                                                                                                                                | 48 h LC <sub>50</sub> s (mg a.i./mL):<br><i>A. melinus</i> : 0.246<br><i>G. ashmeidi</i> : 2.63<br><i>E. erimicus</i> : 1.93<br><i>E. formosa</i> : 0.98<br><br>96 h LC <sub>50</sub> s (mg a.i./mL):<br><i>G. punctipes</i> : 5.18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Prabhaker <i>et al.</i> 2011 (PMRA 2576351); WIA 2014a (PMRA 2545410)  |

| Species                                                                                       | Test substance/application rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Endpoint observed                                                                                                                                                                            | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reference                                                        |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                              | <i>O. insidiosus</i> : 2.78                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                  |
|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                              | The exposure concentrations used to systemically treat leaves are not reported; based on the concentration range of the $IC_{50}$ values (mg a.i./mL = g a.i./L), the exposure range is not environmentally relevant.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                  |
| Predatory beetle<br><i>Coleomegilla maculata</i><br>(Coleoptera: Coccinellidae)               | Marathon 1% a.i. granular<br><br>Application to potted plants (dandelion – <i>T. officinale</i> , sunflower – <i>H. annuus</i> L., chrysanthemum – <i>C. morifolium</i> ): 0 (control), 1 and 2x label rate (20 and 40 mg per pot, respectively). Bioassay was conducted 10, 25 and 36 days after application to plants, respectively.<br><br>A starvation treatment was included to determine the effects of 7 d without access to pollen or nectar. Beetles were confined to flower heads of untreated and treated plants; only pollen and nectar produced by the flower head was available as food.                              | Mobility: walk rate, flip rate (measured after 7d exposure)<br><br>Survivorship, days to 1 <sup>st</sup> oviposition and daily egg production (monitored for 30d after a 7d exposure period) | <u>Mobility</u> : Walk rate and flip rate was significantly decreased in each plant system; the magnitude of the reduction varied with plant species.<br><br><u>Sunflower bioassay</u> : survivorship was lower for beetles exposed to both the 1x label rate and 2x label rate (38 and 20% survival, respectively; 98% survival in untreated controls). Beetles took longer to produce their 1st eggs (9.7 and 14 days after bioassay, respectively; 2.6 days for controls).<br><br><u>Chrysanthemum and dandelion bioassay</u> : No treatment effect on survivorship or days to 1st oviposition.<br><br>No statistically significant difference between survivorship, for beetles from the untreated plants (97.5%) and the starvation treatment (85.5%).<br><br>The study design does not follow an appropriate dose-response method; a suitable NOEC cannot be derived from the study results. Results, however, do indicate that the use of imidacloprid may not be compatible with the coccinellid predator <i>C. maculata</i> . | Smith and Krischik 1999 (PMRA 2574043); WIA 2014a (PMRA 2545410) |
| Parasitic wasp<br><i>Aphelinus certus</i>                                                     | Gaucho, 480 g a.i./L; seed treatment<br><br>Tri-trophic bioassay: Exposure to aphids ( <i>Ap. glycines</i> ) feeding on treated soybean plants of different ages. Soybean seeds treated at 0 (control), 83 and 260 mL/100kg seed (equivalent to 40 and 125 g a.i./100 kg seed, respectively). Aphids were introduced to excised leaves taken from plants at 4 weeks after planting, and weekly for 7 weeks thereafter. For each time series test, female adult <i>A. certus</i> were exposed to feeding aphids for 24 h. Parasitoids were then removed and aphids monitored daily for 8 days for live, dead and parasitized aphids. | # of aphids parasitized/day<br><br>Parasitism rates of <i>A. certus</i> with aphids feeding on soybean plants of different ages.                                                             | <i>A. certus</i> was able to parasitize soybean aphids feeding on imidacloprid-treated plants 5 weeks after planting. However, up to 10 wk after planting, overall parasitism rates were reduced by 69-88% compared with the control.<br><br>The study design does not follow an appropriate dose-response method; a suitable NOEC cannot be derived from the study results. Results, however, do indicate that the use of imidacloprid may reduce the effectiveness of <i>A. certus</i> as a natural enemy of soybean aphid in seed-treated crops.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Frewin et al. 2014; PMRA 2574036                                 |
| Predatory fauna:<br><br>Araneae<br>Heteroptera<br>Carabidae<br>Coccinellidae<br>Staphylinidae | Experimental field plots: Field sown with untreated and treated corn seed (Gaucho 35 FS – 4.9 g a.i./kg seed). Study was conducted for 5 consecutive corn growing seasons.                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Composition and abundance of epigeal predatory fauna was measured (visual sampling) in fields each year at various periods of crop development.<br><br>Activity of soil predators: pitfall   | Among the prevalent predator groups found in visual sampling, Araneae, Coccinellidae, and Staphylinidae were not affected by the imidacloprid treatment, whereas Carabidae was only moderately affected in one of the 5 yr studied. Heteroptera was more drastically reduced but the effect varied with the year. The authors postulate that a reduction of Heteroptera species (for example, <i>Ortus</i> spp.) could lead to the enhancement of the European corn borer populations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Albajes et al. 2003; PMRA 2574046; WIA 2014a (PMRA 2545410)      |



| Species                                            | Test substance/application rate                                                                                                                                                                                                                                                                                                                                                 | Endpoint observed                                                                                                                                                                                                                        | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reference                                                          |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
|                                                    |                                                                                                                                                                                                                                                                                                                                                                                 | traps - traps left active in fields at weekly intervals (duration of sampling per year not reported).<br><br>Predators identified to species, genus, family or order.                                                                    | In pitfall traps, only Staphylinidae resulted in lower numbers as consequence of the treatment, whereas the rest of the most abundant predator groups, Carabidae, Araneae, Dermaptera, Opiliones, Trombididae and Heteroptera, were not caught in significantly different numbers in treated or untreated plots.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                    |
| Phytophagous and transient canopy insect community | Exposure resulting from three imidacloprid treatments to control hemlock woolly adelgid infestation of eastern hemlock:<br>1) Tree injection (Mauget 3mL 10% imicide capsules; 0.15 mL a.i./2.5 cm dbh)<br>2) Soil injection (Merit 75WP, 1 g a.i./2.5 cm dbh)<br>3) Soil drench (Merit 75WP, 1.5 g a.i./2.5 cm dbh)<br><br>Trees were treated either Fall 2005 or Spring 2006. | Community response: species composition, richness and abundance.<br><br>Effects on functional structure: species richness and abundance by guilds (detritivore, fungivore, hematophaga, phytophaga, scavenger and transient phytophaga). | Community composition differed significantly among treatments. Mean species richness and specimen abundance were significantly reduced by one or more treatments.<br><br>Soil drench applications significantly reduced species richness for the detritivore and phytophaga guilds. Specimen abundance for species in the detritivore, fungivore, phytophaga, scavenger, and transient phytophaga guilds was significantly lower in the soil drench treatment. This trend was consistent in all insect guilds examined, with the exception of the hematophaga guild that was not significantly lower than for species on the control trees. Of 293 species documented to be associated with eastern hemlocks, 33 species were found to be directly effected by one or more of the chemical treatments. | Dilling <i>et al.</i> 2009; PMRA 2574047; WIA 2014a (PMRA 2545410) |

Table 4 Terrestrial plant toxicity data

| Plant species                                                                                                                                                                                                                                                                                                                                                                                                       | Test substance                        | Exposure                                                                          | Endpoint                                                                | Comments                                                                                                                                    | Reference (PMRA #)           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <u>4 dicots</u> : oilseed rape ( <i>Brassica napus</i> ), sunflower ( <i>Helianthus annuus</i> L.), soybean ( <i>Glycine max</i> ), cucumber ( <i>Cucumis sativus</i> ).<br><br><u>2 monocots</u> : corn ( <i>Zea mays</i> ), oats ( <i>Avena sativa</i> )                                                                                                                                                          | Imidacloprid SL200                    | 200 g a.i./ha<br><br>Seedling emergence<br><br>Vegetative vigour (2-4 leaf stage) | EC <sub>50</sub> > 200<br><br>EC <sub>50</sub> > 200<br><br>(g a.i./ha) | Tier 1 study: No significant effect on seedling emergence, visual phytotoxicity, survival or plant biomass.                                 | 1429593 / 1429596            |
| <u>6 dicots</u> : oilseed rape ( <i>Brassica napus</i> ), sunflower ( <i>Helianthus annuus</i> L.), soybean ( <i>Glycine max</i> ), cucumber ( <i>Cucumis sativus</i> ), sugar beets ( <i>Beta vulgaris</i> ), tomato ( <i>Lycopersicon esculentum</i> ).<br><br><u>4 monocots</u> : corn ( <i>Zea mays</i> ), onion ( <i>Allium cepa</i> ), barley ( <i>Hordeum vulgare</i> ), wheat ( <i>Triticum aestivum</i> ). | Imidacloprid SC240 DG                 | 560 g a.i./ha<br><br>Seedling emergence<br><br>Vegetative vigour (2-4 leaf stage) | EC <sub>50</sub> > 560<br><br>EC <sub>50</sub> > 560<br><br>(g a.i./ha) | Tier 1 study: No significant effect on seedling emergence, visual phytotoxicity, survival, growth, shoot length or shoot dry weight.        | 2146458 / 2146457            |
| <u>2 dicots</u> : turnip ( <i>Brassica rapa</i> ), cress ( <i>Lepidium sativum</i> ).                                                                                                                                                                                                                                                                                                                               | Technical imidacloprid (98.6% purity) | 0, 1, 10 and 100 mg a.i./kg dw soil                                               |                                                                         | Visual phytotoxic symptoms were observed for oat and cress at 10 mg a.i./kg dw soil and for all three species at 100 mg a.i./kg dw soil. No | EFSA 2008 (2332663; original |

|                                                                                                                                                                                                                                                |                        |                                                                                               |                                                |                                                                                                     |                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------|---------------------|
| 1 monocot: oats ( <i>Avena sativa</i> )                                                                                                                                                                                                        |                        | Seedling emergence and growth                                                                 | EC <sub>50</sub> > 100<br>(mg a.i./kg dw soil) | significant effect on seedling emergence, survival, growth (shoot fresh weight).                    | study 1429590       |
| 2 dicots: sugar beets ( <i>Beta vulgaris</i> ), wild mustard ( <i>Sinapis arvensis</i> ), cocklebur ( <i>Xanthium sp.</i> ), redroot amaranth ( <i>Amaranthus retroflexus</i> ), velvetleaf ( <i>Abutilon theophrasti</i> ).                   | Technical imidacloprid | 1000 g a.i./ha<br><br>Pre-emergence and post emergence: mean plant weight and visible damage. | EC <sub>50</sub> > 1000                        | No phytotoxic effects of ~50% were observed up to the highest tested concentration of 1 kg a.s./ha. | EFSA 2008 (2332663) |
| 6 monocots: green foxtail ( <i>Setaria viridis</i> ), wild oat ( <i>Avena fatua</i> ), barnyard grass ( <i>Echinochloa crus-galli</i> ), cleavers ( <i>Galium aparine</i> ), corn ( <i>Zea mays</i> ), foxtail ( <i>Alopecurus myodoneae</i> ) |                        |                                                                                               |                                                |                                                                                                     |                     |

Table 5 Avian acute oral toxicity endpoints

| Bird species                                  | Test substance                        | Endpoint                                                                                                                  | Toxicity value <sup>a</sup>                                    | Reference (PMRA #)                                                 |
|-----------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------------|
| Bobwhite quail ( <i>Colinus virginianus</i> ) | NR                                    | 14-d LD <sub>50</sub><br>NOEL (clinical signs; onset of serious incapacitation between 50 and 100 mg/kg)                  | 152 mg a.i./kg bw<br>25 mg a.i./kg bw                          | USDA 2005 (2334762; original study 1155842)                        |
| Mallard duck ( <i>Anas platyrhynchos</i> )    | Imidacloprid technical (96.6%)        | 14-d LD <sub>50</sub><br>NOEL (ataxia, hyporeactivity, immobility, diarrhea)                                              | 283 mg a.i./kg bw<br>< 25 mg a.i./kg bw                        | 1182374                                                            |
| Canary ( <i>Serinus canarius</i> )            | Imidacloprid technical (94.8%)        | 7-d LD <sub>50</sub><br><br>Acute LOAEL (clinical signs of neurotoxicity; serious incapacitation at lowest dose 10 mg/kg) | 35 mg a.i./kg bw<br><br>10 mg a.i./kg bw                       | USDA 2005 (2334762; original study 1157923)                        |
| House sparrow ( <i>Passer domesticus</i> )    | NTN 33893 (2.5G granular formulation) | 7-d LD <sub>50</sub><br><br>NOEL                                                                                          | 41 mg a.i./kg bw (419 granules per sparrow)<br>3 mg a.i./kg bw | USDA 2005 (2334762); EFED 2008 (2332665); (original study 1157921) |
| Japanese quail ( <i>Coturnix japonica</i> )   | Imidacloprid technical (95.3%)        | 14-d LD <sub>50</sub><br>NOEL (clinical signs of neurotoxicity; severe clinical signs at 5 mg/kg)                         | 31 mg a.i./kg bw<br>3.1 mg a.i./kg bw                          | EFSA 2008 (2332663; original study 1157924)                        |

|                                    |                                   |                                                                             |                                                                                                                                                                                                     |                                                                                                                    |
|------------------------------------|-----------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Pigeon<br>( <i>Columba livia</i> ) | Imidacloprid technical<br>(94.8%) | 7-d NOEC (mortality) LOAEL (clinical signs, apathy, cramps, prone position) | 12.5 mg a.i./kg bw<br>25 mg a.i./kg bw<br>Note: Inadequate number of birds per test concentration (2 males and 2 females); accurate LD <sub>50</sub> cannot be determined based on low sample size. | USDA 2005<br>(2334762; original study 1157922)                                                                     |
| Gray partridge                     | NR                                | LD <sub>50</sub>                                                            | 15 mg a.i./kg bw                                                                                                                                                                                    | Reported by Mineau and Palmer 2013 (2544546 – originally reported by Grolleau 1990 in Environment Canada database) |
| Rock dove                          | NR                                | LD <sub>50</sub>                                                            | 25 mg a.i./kg bw (female value; male approximate 25 – 50).<br>Severe signs at lowest dose – 12.5 mg/kg.                                                                                             | Reported by Mineau and Palmer 2013 (2544546 – originally study cited as Grau 1987)                                 |

NR – Not reported.

\* Endpoints in bold were used to determine the HD<sub>5</sub> (the 5<sup>th</sup> percentile of the species sensitivity distribution for the LC<sub>50</sub> at 50% confidence intervals). HD<sub>5</sub> = 8.07 mg a.i./kg bw.**Table 6 Avian dietary toxicity endpoints**

| Bird species                                     | Test substance                    | Endpoint                                                                                                    | Toxicity value                                                                                                                 | Reference                                                |
|--------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Bobwhite quail<br>( <i>Colinus virginianus</i> ) | NR                                | NOEC (mortality; short term exposure - chicks); NOEL                                                        | 156 mg a.i./kg diet;<br>29.4 mg a.i./kg bw/day                                                                                 | EFSA 2008<br>(PMRA 2332663)                              |
|                                                  | Imidacloprid technical<br>(94.8%) | 8-d LC <sub>50</sub><br>NOEC (mortality)                                                                    | 1536 mg a.i./kg diet<br>< 69 mg a.i./kg diet                                                                                   | EFED 2008<br>(PMRA 2332665; original study PMRA 1155843) |
| Mallard duck<br>( <i>Anas platyrhynchos</i> )    | Imidacloprid technical<br>(97.4%) | 8-d LC <sub>50</sub><br>8-d LD <sub>50</sub>                                                                | > 4797 mg a.i./kg diet<br>237 mg a.i./kg bw/day <sup>1</sup>                                                                   | EFED 2008<br>(PMRA 2332665; original study PMRA 1155844) |
|                                                  | Imidacloprid technical<br>(94.8%) | NOAEC (mortality)                                                                                           | > 5000 ppm<br>Significantly decreased body weight on day 5 at > 150 ppm.                                                       | USDA 2005<br>(PMRA 2334762)                              |
| Ringed turtle dove                               | NR                                | Acute LOAEC (reduced body weight, food consumption, clinical signs, ataxia, fluffed feathers, hypoactivity) | 228 ppm diet                                                                                                                   | USDA 2005<br>(PMRA 2334762)                              |
| Japanese quail<br>( <i>Coturnix japonica</i> )   | Imidacloprid technical<br>(97.7%) | 8-d LC <sub>50</sub><br>8-d LD <sub>50</sub><br><br>LOEC (mortality, apathy, narcosis); NOEL                | 473.7 mg a.i./kg diet<br>48.5 mg a.i./kg bw/day <sup>2</sup><br><br>313 mg a.i./kg diet; < 40.3 mg a.i./kg bw/day <sup>2</sup> | USDA 2005<br>(PMRA 2334762; original study PMRA 1157925) |

NR – Not reported.

<sup>1</sup> LC<sub>50</sub> (mg a.i./diet) for mallard converted to mg a.i./kg bw/day using: (Concentration in diet × FIR)/BW

Mean food consumption (g/bird/day) for 5 day exposure period = 7.3 g diet/bird/day for 4797 mg/kg diet treatment level; mean body weight (BW) for 4797 mg/kg diet treatment level at day 0 = 168 g/bird, day 5 = 128 g/bird; mean BW from day 0-5 = 148 g/bird.

<sup>2</sup> LC<sub>50</sub> (mg a.i./diet) for Japanese quail converted to mg a.i./kg bw/day using: (Concentration in diet × FIR)/BW

Mean feed consumption (g/bird/day) for 5 day exposure period = 4.835 g diet/bird/day for all treatment levels; mean body weight (BW) for all treatment level from day 0 to day 5 = 43.58 g/bird. LOEC converted to NOEL: (Concentration in diet × FIR)/BW

Mean feed consumption (g/bird/day) for 5 day exposure period = 5.98 g diet/bird/day for 313 mg/kg diet treatment level; mean body weight (BW) for 313 mg/kg diet treatment level at day 0 to 5 = 43.65 g/bird.

**Table 7 Avian chronic toxicity endpoints**

| Bird species                                      | Test substance                                                                                                                                                               | Endpoint                                                                                                                            | Toxicity value (NOEC or NOEL)                                          | Reference                                                |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------------|
| Bobwhite quail                                    | Imidacloprid technical (94.8%)                                                                                                                                               | Reproduction - one generation:<br>NOAEC Male adult weight                                                                           | 126 ppm<br>8.1 mg a.i./kg bw/day <sup>1</sup>                          | USDA 2005<br>(PMRA 2334762; original study PMRA 1155846) |
|                                                   |                                                                                                                                                                              | Variable results, aberrant controls. No true reproductive effect observed.                                                          | 243 ppm<br>15.61 mg a.i./kg bw/day <sup>1</sup>                        |                                                          |
|                                                   | NR                                                                                                                                                                           | NOAEL (long term – endpoint not specified)                                                                                          | 9.3 mg a.i./kg bw/day                                                  | EFSA 2008<br>(PMRA 2332663)                              |
| Mallard duck<br>( <i>Anas platyrhynchos</i> )     | Imidacloprid technical (94.8%)                                                                                                                                               | chronic NOAEC (eggs laid, viability, hatchling survival and growth; study conducted longer than normal leading to high variability) | 125 ppm<br>10 mg a.i./kg bw/day <sup>2</sup>                           | USDA 2005<br>(PMRA 2334762; original study PMRA 1155847) |
|                                                   | Imidacloprid technical (95.8%)                                                                                                                                               | chronic NOAEC (eggshell thickness/strength)                                                                                         | 128 ppm<br>10 mg a.i./kg bw/day <sup>3</sup>                           | USDA 2005<br>(PMRA 2334762; original study PMRA 1155848) |
|                                                   | NR                                                                                                                                                                           | chronic LOAEC (eggshell thickness and strength)                                                                                     | 250 ppm                                                                | USDA 2005<br>(PMRA 2334762)                              |
|                                                   | NR                                                                                                                                                                           | chronic NOAEC (eggshell thickness and strength, mortality, clinical signs)                                                          | ≥47 ppm<br>(highest dose tested)<br>2.7 mg a.i./kg bw/day <sup>4</sup> | USDA 2005 (PMRA 2334762); EFED 2008 (PMRA 2332665)       |
| Red-legged partridge<br>( <i>Alectoris rufa</i> ) | Seed treatment product: Excocet® – 35% a.i. w/v; 200 and 400 cm <sup>3</sup> /100 kg seed.<br>10 day dietary exposure to treated wheat seed at 0, 0.519 and 0.869 mg a.i./g. | NOEC (survival, physiological/biological parameters associated with oxidative stress, immune and reproductive system function)      | NOEC < 0.519 mg a.i./g                                                 | Lopez-Antia <i>et al.</i> 2013, (PMRA 2544545)           |

NR – Not reported.

<sup>1</sup> The USDA reports the NOEC - NOEL as 36 mg a.i./kg diet - 2.25 mg a.i./kg bw/day, respectively, based on hatchling mortality. The NOEL value reported by USDA 2005 was calculated: 36 mg/kg diet × 0.018 kg diet/day × a/0.288 kg bird = 2.25 mg imidacloprid/kg bird/day; based on experimental data and mean female body weight for birds fed 36 ppm imidacloprid in the diet. There is, however, no evidence of hatchling mortality in the original study data. The NOEC reported by the study authors (and cited by Mineau and Palmer 2013, PMRA 2544546) is 126 mg a.i./kg diet based on reduced male adult bodyweight; no biologically significant reproductive effects were visible in the original study data.

The WIA (Gibbons *et al.* 2014; PMRA 2545412) reports a NOEL of 24 mg a.i./kg/day in WIA for this study; this value is “adapted from Figures in Mineau and Palmer 2013 – various effects on weight”). The NOEL of 8.1 mg a.i./kg bw/day (based on reduced adult male weight at 126 mg a.i./kg diet) and NOEL of 15.6 mg a.i./kg bw/day (based on no reproductive effects observed at the highest dietary concentration, 243 mg a.i./kg diet) was calculated by the PMRA reviewer using combined mean of male and female adult mallard body weights and feed consumption values from week 1 to 8 and week 20 (weights from week 9 to 19 were not reported). Feed consumption was reported as combined value for male and female consumption.



- <sup>2</sup> For same study, the NOEL is listed as 16 mg a.i./kg/day in WIA (Gibbons et al 2014; PMRA 2545412); this value is said to be "adapted from Figures in Mineau and Palmer 2013 – various effects on reproduction". A NOEL of 10 mg a.i./kg bw/day was calculated by the PMRA reviewer using combined mean of male and female adult mallard body weights and food consumption values from week 1 to 8 and week 21 (weights from week 9 to 20 were not reported). Food consumption was reported as combined value for male and female consumption.
- <sup>3</sup> The NOEL was calculated by the PMRA reviewer using combined mean of male and female adult mallard body weights and food consumption values from week 1 to 8 and week 20 (weights from week 9 to 19 were not reported). Food consumption was reported as combined value for male and female consumption.
- <sup>4</sup> The NOEL was calculated by the PMRA reviewer using default adult mallard body weight (1082 g; Dunning 1993) and food ingestion rate (61.2 g dw food/day; Nagy 1987 - FIR (g dry weight/day) = 0.648(BW in g)<sup>0.691</sup>).

Table 8 Mammalian toxicity endpoints

| Study Type/ Animal/<br>PMRA#                   | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Reference (PMRA #) |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| <b>ACUTE STUDIES - Technical Imidacloprid</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                    |
| Oral<br>Wistar rat                             | LD <sub>50</sub> (♂) = 642 mg/kg bw; LD <sub>50</sub> (♀) = 648 mg/kg bw<br><br>Clinical signs included apathy, staggering or spastic gait, labored breathing, spasms or transient spasms, transient tremors, decreased motility, increased water intake, diuresis, piloerection, hypersalivation, absence of feces and transient convulsions.                                                                                                                                                                                                                                                                                                                                                            | 2030939            |
| Oral<br>Wistar rat                             | LD <sub>50</sub> (♂) = 504 mg/kg bw; LD <sub>50</sub> (♀) = 379 mg/kg bw<br><br>Clinical signs included apathy, staggering and spastic gait, labored breathing, reduced motility, spasmodic state (periodic in some cases), periodic tremors, soft feces and piloerection                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2030940            |
| Oral<br>Wistar rat                             | LD <sub>50</sub> (♂) = 424 mg/kg bw; LD <sub>50</sub> (♀) = 450-475 mg/kg bw<br><br>Clinical signs at ≥ 100 mg/kg bw (♂) or 250 mg/kg bw (♀): ↓ motility, apathy, breathing disturbances, staggered gait, narrowed palpebral fissures, transient trembling and/or spasms (resolved 2-6 days).                                                                                                                                                                                                                                                                                                                                                                                                             | 1155724            |
| <b>REPRODUCTION AND DEVELOPMENTAL TOXICITY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                    |
| Multi-generation dietary<br>Wistar rat         | <b>Parental</b><br>NOAEL = 250 ppm (16.5/18.9 mg/kg bw/day; ♂/♀)<br><br>700 ppm (47.3/ 52.3 mg/kg bw/day): ↓ bwg during prenatation (F <sub>0</sub> ), ↑ demethylase activity; ↓ bwg (F <sub>1</sub> ♀) during prenatation, 1 <sup>st</sup> gestation, and 2 <sup>nd</sup> gestation; ↑ bwg during lactation (F <sub>1A/B</sub> , F <sub>2A/B</sub> ); ↑ cytochrome P450 content (♂); ↓ fc (♀).<br><br><b>Reproductive</b><br>NOAEL > 700 ppm (47.3/52.3 mg/kg bw/day)<br>LOAEL not established.<br>No treatment-related findings.<br><br><b>Offspring</b><br>NOAEL = 250 ppm (18.9 mg/kg bw/day)<br><br>700 ppm (52.3 mg/kg bw/day): ↓ pup wt during lactation (F <sub>1A/B</sub> , F <sub>2A/B</sub> ). | 1155687, 1155688   |

| Study Type/ Animal/<br>PMRA#                                | Study Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Reference (PMRA #) |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Developmental toxicity<br>Sprague Dawley rat                | <p>Note: study report dated 1990 - limited organ weights (liver, ovaries, testes), no sperm assessment, no ovarian follicle counts.</p> <p><b>Maternal</b><br/>NOAEL = 10 mg/kg bw/day</p> <p>30 mg/kg bw/day: ↓ bwg GD 6-11 and 6-16, ↓ corrected bwg GD 6-21, ↓ fc GD 6-11.</p> <p>100 mg/kg bw/day: ↓ bwg, ↓ corrected bwg GD 6-21, ↓ fc during treatment, ↑ fc post-dosing.</p> <p><b>Developmental</b><br/>NOAEL = 30 mg/kg bw/day</p> <p>100 mg/kg bw/day: slight ↑ in incidence of wavy ribs.</p> <p>No evidence of sensitivity of the young.</p>                                                                                                                                                                                                                                                                                                           | 1155698            |
| Developmental toxicity - Range-finding<br>Chinchilla rabbit | <p>Supplemental. NOAEL not established.</p> <p><b>Maternal</b><br/>≥50 mg/kg bw/day: ↓ bw and fc.</p> <p>100 mg/kg bw/day: ↑ post-implantation loss, markedly ↓ number of live fetuses per dam</p> <p><b>Developmental</b><br/>≥50 mg/kg bw/day: ↓ fetal wt.</p> <p>100 mg/kg bw/day: markedly ↓ number of live fetuses per dam</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2428119            |
| Developmental toxicity<br>Chinchilla rabbit                 | <p><b>Maternal</b><br/>NOAEL = 8 mg/kg bw/day</p> <p>24 mg/kg bw/day: transient ↓ bwg and fc during dosing.</p> <p>72 mg/kg bw/day: 2 unscheduled deaths (GD 18, 19), 1 abortion (GD 26), 2 total litter resorptions, ↓ bw GD 17-21, ↓ bwg, body weight loss during dosing, ↓ fc during treatment and post-dosing, ↑ late resorptions, ↓ postimplantation loss, ↑ number of live fetuses/litter.</p> <p><b>Developmental</b><br/>NOAEL = 24 mg/kg bw/day</p> <p>72 mg/kg bw/day: 1 abortion (GD 26), 2 total litter resorptions, ↑ late resorptions, ↑ postimplantation loss, ↓ number of live fetuses/litter, ↓ litter weights, ↓ fetal wt (more pronounced in ♀), slight ↑ in skeletal malformations (fused, asymmetric, missing and abnormally ossified sternebrae, shortened tail) - total of 5/83 fetuses (3/11 litters) versus 0/136 (0/16) in controls.</p> | 1155699            |

| Study Type/ Animal/<br>PMRA# | Study Results                                       | Reference (PMRA #) |
|------------------------------|-----------------------------------------------------|--------------------|
|                              | Evidence of malformations at maternally-toxic dose. |                    |

Table 9 Risk assessment for foliar dwelling beneficial arthropods

| Organism / endpoint                                      | Crop                                     | Application rate<br>(g a.i./ha, field<br>sprayer) | On field                        |    |                 | Off-field                       |     |                 |
|----------------------------------------------------------|------------------------------------------|---------------------------------------------------|---------------------------------|----|-----------------|---------------------------------|-----|-----------------|
|                                                          |                                          |                                                   | EEC <sup>1</sup><br>(g a.i./ha) | RQ | LOC<br>exceeded | EEC <sup>2</sup><br>(g a.i./ha) | RQ  | LOC<br>exceeded |
| Parasitic wasp <i>A. Rhopalosiphii</i><br>0.45 g a.i./ha | Crop group 13B: Berry and<br>small fruit | 42                                                | 33.6                            | 75 | Yes             | 0.46                            | 1.0 | Yes             |

<sup>1</sup> In-field EEC = application rate × crop interception factor (80%); post bloom application

<sup>2</sup> Off-field EEC = application rate × drift factor (11% for field sprayer application) × vegetation distribution factor – 10%. The vegetation distribution factor is applied since drift is overestimated to the lower or interior portions of a three-dimensional habitat structure. Most of the drift would be intercepted by the top or side portions of the habitat.

Table 10 Screening level risk assessment for imidacloprid for birds and mammals at the highest foliar application rate on turf

|                               | Toxicity<br>(mg a.i./kg bw/d) | Feeding Guild (food item) | EDE<br>(mg a.i./kg bw) | RQ   | LOC Exceeded? |
|-------------------------------|-------------------------------|---------------------------|------------------------|------|---------------|
| Small Sized Bird (0.02 kg)    |                               |                           |                        |      |               |
| Acute                         | 8.07                          | Insectivore               | 22.9                   | 2.8  | Yes           |
| Reproduction                  | 10.0                          | Insectivore               | 22.9                   | 2.3  | Yes           |
| Medium Sized Bird (0.1 kg)    |                               |                           |                        |      |               |
| Acute                         | 8.07                          | Insectivore               | 17.9                   | 2.2  | Yes           |
| Reproduction                  | 10.0                          | Insectivore               | 17.9                   | 1.8  | Yes           |
| Large Sized Bird (1 kg)       |                               |                           |                        |      |               |
| Acute                         | 8.07                          | Herbivore (short grass)   | 11.5                   | 1.4  | Yes           |
| Reproduction                  | 10.0                          | Herbivore (short grass)   | 11.5                   | 1.2  | Yes           |
| Small Sized Mammal (0.015 kg) |                               |                           |                        |      |               |
| Acute                         | 37.9                          | Insectivore               | 13.2                   | 0.35 | No            |
| Reproduction                  | 18.9                          | Insectivore               | 13.2                   | 0.70 | No            |

|                                        | Toxicity<br>(mg a.i./kg bw/d) | Feeding Guild (food item) | EDE<br>(mg a.i./kg bw) | RQ   | LOC Exceeded? |
|----------------------------------------|-------------------------------|---------------------------|------------------------|------|---------------|
| <b>Medium Sized Mammals (0.035 kg)</b> |                               |                           |                        |      |               |
| Acute                                  | 37.9                          | Herbivore (short grass)   | 25.5                   | 0.67 | No            |
| Reproduction                           | 18.9                          | Herbivore (short grass)   | 25.5                   | 1.4  | Yes           |
| <b>Large Sized Mammals (1 kg)</b>      |                               |                           |                        |      |               |
| Acute                                  | 37.9                          | Herbivore (short grass)   | 13.65                  | 0.36 | No            |
| Reproduction                           | 18.9                          | Herbivore (short grass)   | 13.65                  | 0.72 | No            |

**Table 11 Avian risk assessment using maximum and mean imidacloprid residue values based on the maximum cumulative agricultural rate (raspberry – 112 g a.i./ha × 3 at 7-day intervals) and the highest application rate for turf use (281.25 g a.i./ha)**

|                                                                     |                                     |                              | <b>Maximum nomogram residues</b> |     |                        |     | <b>Mean nomogram residues</b> |     |                              |     |
|---------------------------------------------------------------------|-------------------------------------|------------------------------|----------------------------------|-----|------------------------|-----|-------------------------------|-----|------------------------------|-----|
|                                                                     |                                     |                              | <b>On-field</b>                  |     | <b>Off Field</b>       |     | <b>On-field</b>               |     | <b>Off Field</b>             |     |
|                                                                     | Toxicity<br>(mg<br>a.i./kg<br>bw/d) | Food Guild (food item)       | EDE (mg<br>a.i./kg<br>bw)        | RQ  | EDE (mg<br>a.i./kg bw) | RQ  | EDE<br>(mg<br>a.i./kg<br>bw)  | RQ  | EDE<br>(mg<br>a.i./kg<br>bw) | RQ  |
| <b>Raspberry – 112 g a.i./ha × 3 at 7-day intervals<sup>1</sup></b> |                                     |                              |                                  |     |                        |     |                               |     |                              |     |
| <b>Small Bird (0.02 kg)</b>                                         |                                     |                              |                                  |     |                        |     |                               |     |                              |     |
| Acute                                                               | 8.07                                | Insectivore                  | 18                               | 2.3 | 13                     | 1.7 | 13                            | 1.6 | 9.3                          | 1.2 |
| Reproduction                                                        | 10.0                                | Insectivore                  | 18                               | 1.8 | 13                     | 1.4 | 13                            | 1.3 | 9.3                          | 0.9 |
| <b>Medium Sized Bird (0.1 kg)</b>                                   |                                     |                              |                                  |     |                        |     |                               |     |                              |     |
| Acute                                                               | 8.07                                | Insectivore                  | 14                               | 1.8 | 11                     | 1.3 | 9.8                           | 1.2 | 7.3                          | 0.9 |
| Reproduction                                                        | 10.0                                | Insectivore                  | 14                               | 1.4 | 11                     | 1.1 | 9.8                           | 1.0 | 7.3                          | 0.7 |
| <b>Large Sized Bird (1 kg)</b>                                      |                                     |                              |                                  |     |                        |     |                               |     |                              |     |
| Acute                                                               | 8.07                                | Herbivore (short grass)      | 9.2                              | 1.1 | 6.8                    | 0.8 | 3.3                           | 0.4 | 2.4                          | 0.3 |
|                                                                     | 8.07                                | Herbivore (Broadleaf plants) | 8.5                              | 1.1 | 6.3                    | 0.8 | 2.8                           | 0.4 | 2.1                          | 0.3 |
| Reproduction                                                        | 10.0                                | Herbivore (short grass)      | 9.2                              | 0.9 | 6.8                    | 0.7 | 3.3                           | 0.3 | 2.4                          | 0.2 |
|                                                                     | 10.0                                | Herbivore (Broadleaf plants) | 8.5                              | 0.9 | 6.3                    | 0.6 | 2.8                           | 0.3 | 2.1                          | 0.2 |



| Turf use - 281.25 g a.i./ha |      |                              |    |            |     |     |     |            |     |      |
|-----------------------------|------|------------------------------|----|------------|-----|-----|-----|------------|-----|------|
| Small Bird (0.02 kg)        |      |                              |    |            |     |     |     |            |     |      |
| Acute                       | 8.07 | Insectivore                  | 23 | <b>2.8</b> | 2.5 | 0.3 | 16  | <b>2.0</b> | 1.7 | 0.2  |
| Reproduction                | 10.0 | Insectivore                  | 23 | <b>2.3</b> | 2.5 | 0.3 | 16  | <b>1.6</b> | 1.7 | 0.2  |
| Medium Sized Bird (0.1 kg)  |      |                              |    |            |     |     |     |            |     |      |
| Acute                       | 8.07 | Insectivore                  | 18 | <b>2.2</b> | 2.0 | 0.2 | 12  | <b>1.5</b> | 1.4 | 0.2  |
| Reproduction                | 10.0 | Insectivore                  | 18 | <b>1.8</b> | 2.0 | 0.2 | 12  | <b>1.2</b> | 1.4 | 0.1  |
| Large Sized Bird (1 kg)     |      |                              |    |            |     |     |     |            |     |      |
| Acute                       | 8.07 | Herbivore (short grass)      | 12 | <b>1.4</b> | 1.3 | 0.2 | 4.1 | 0.5        | 0.5 | <0.1 |
|                             | 8.07 | Herbivore (Broadleaf plants) | 11 | <b>1.3</b> | 1.2 | 0.2 | 3.5 | 0.4        | 0.4 | <0.1 |
| Reproduction                | 10.0 | Herbivore (short grass)      | 12 | <b>1.2</b> | 1.3 | 0.1 | 4.1 | 0.4        | 0.5 | <0.1 |
|                             | 10.0 | Herbivore (Broadleaf plants) | 11 | <b>1.1</b> | 1.2 | 0.1 | 3.5 | 0.4        | 0.4 | <0.1 |

Values in bold indicate RQ>1.

<sup>1</sup> The cumulative application rate for raspberry is based on a default half-life of 10 days for foliar dissipation. This value is based on the foliar dissipation of a variety of active ingredients reported by Willis and McDowell, 1987 (PMRA 1930629); with 93% of the foliar dissipation half-life less than 10 days, this value is considered to be a reasonable conservative estimate of typical foliar half-lives.

**Table 12 Mammalian risk assessment using maximum and mean imidacloprid residue values based on the maximum cumulative agricultural rate (raspberry – 112 g a.i./ha × 3 at 7-day intervals) and the highest application rate for turf use (281.25 g a.i./ha)**

|                                                               |                                     |                         | Maximum nomogram residues |            |                           |     | Mean nomogram residues    |     |                           |     |
|---------------------------------------------------------------|-------------------------------------|-------------------------|---------------------------|------------|---------------------------|-----|---------------------------|-----|---------------------------|-----|
|                                                               |                                     |                         | On-field                  |            | Off Field                 |     | On-field                  |     | Off Field                 |     |
|                                                               | Toxicity<br>(mg<br>a.i./kg<br>bw/d) | Food Guild (food item)  | EDE (mg<br>a.i./kg<br>bw) | RQ         | EDE (mg<br>a.i./kg<br>bw) | RQ  | EDE (mg<br>a.i./kg<br>bw) | RQ  | EDE (mg<br>a.i./kg<br>bw) | RQ  |
| Raspberry – 112 g a.i./ha × 3 at 7-day intervals <sup>1</sup> |                                     |                         |                           |            |                           |     |                           |     |                           |     |
| Medium sized mammals (0.035 kg)                               |                                     |                         |                           |            |                           |     |                           |     |                           |     |
| Reproduction                                                  | 18.9                                | Herbivore (short grass) | 20                        | <b>1.1</b> | 15                        | 0.8 | 7.2                       | 0.4 | 5.3                       | 0.3 |

Turf use - 281.25 g a.i./ha

**Medium sized mammals (0.035 kg)**

|              |      |                              |    |            |     |     |     |     |     |      |
|--------------|------|------------------------------|----|------------|-----|-----|-----|-----|-----|------|
| Reproduction | 18.9 | Herbivore (short grass)      | 26 | <b>1.4</b> | 2.8 | 0.2 | 9.1 | 0.5 | 1.0 | <0.1 |
|              |      | Herbivore (Broadleaf plants) | 24 | <b>1.3</b> | 2.6 | 0.1 | 7.8 | 0.4 | 0.9 | <0.1 |

Values in bold indicate RQ&gt;1.

<sup>1</sup> The cumulative application rates for commercial products were based on a default half-life of 10 days for foliar dissipation. This value is based on the foliar dissipation of a variety of active ingredients reported by Willis and McDowell, 1987 (PMRA 1930629) with 93% of the foliar dissipation half-life less than 10 days, this value is considered to be a reasonable conservative estimate of typical foliar half-lives.

**Table 13 Avian risk assessment feeding on insects using maximum and mean imidacloprid residue values based on the maximum cumulative agricultural rate (raspberry – 112 g a.i./ha × 3 at 7-day intervals) and an arthropod DT<sub>50</sub> of 1 day (Wolf 2004, PMRA 2142783)**

|                             | Toxicity<br>(mg<br>a.i./kg<br>bw/d) | Food Guild (food item) | Maximum nomogram residues |            |                           |     | Mean nomogram residues    |     |                           |     |
|-----------------------------|-------------------------------------|------------------------|---------------------------|------------|---------------------------|-----|---------------------------|-----|---------------------------|-----|
|                             |                                     |                        | On-field                  |            | Off Field                 |     | On-field                  |     | Off Field                 |     |
|                             |                                     |                        | EDE (mg<br>a.i./kg<br>bw) | RQ         | EDE (mg<br>a.i./kg<br>bw) | RQ  | EDE (mg<br>a.i./kg<br>bw) | RQ  | EDE (mg<br>a.i./kg<br>bw) | RQ  |
| <b>Small Bird (0.02 kg)</b> |                                     |                        |                           |            |                           |     |                           |     |                           |     |
| Acute                       | 8.07                                | Insectivore            | 9.2                       | <b>1.1</b> | 6.8                       | 0.8 | 6.3                       | 0.8 | 4.7                       | 0.6 |

Values in bold indicate RQ&gt;1.

**Table 14 Seed treatment risk assessment for birds (seed treatments that pose a potential risk are shown only)**

| Crop<br>(EEC: mg a.i./kg seed)                                 | Bird size<br>(g) | EDE<br>(mg a.i./kg bw/day) | RQ                                                |                                              |
|----------------------------------------------------------------|------------------|----------------------------|---------------------------------------------------|----------------------------------------------|
|                                                                |                  |                            | Acute HD <sub>5</sub> :<br>8.07 mg a.i./kg bw/day | Reproduction NOEL:<br>10.0 mg a.i./kg bw/day |
| Canola mustard, Brown and<br>oriental mustard<br>(4000 - 8020) | 20               | 1016 - 2037                | 126 - 252                                         | 102 - 204                                    |
|                                                                | 100              | 798 - 1600                 | 99 - 198                                          | 80 - 160                                     |
|                                                                | 1000             | 233 - 466                  | 29 - 58                                           | 23 - 47                                      |

| Crop<br>(EEC: mg a.i./kg seed)                                                                                                 | Bird size<br>(g) | EDE<br>(mg a.i./kg bw/day) | RQ                                                |                                              |
|--------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------|---------------------------------------------------|----------------------------------------------|
|                                                                                                                                |                  |                            | Acute HD <sub>5</sub> :<br>8.07 mg a.i./kg bw/day | Reproduction NOEL:<br>10.0 mg a.i./kg bw/day |
| Sweet corn<br>(675 – flea beetle,<br>2500 - wireworm)                                                                          | 20               | 171 - 635                  | 21 - 79                                           | 17 - 63                                      |
|                                                                                                                                | 100              | 135 - 499                  | 17 - 62                                           | 13 - 50                                      |
|                                                                                                                                | 1000             | 39 - 145                   | 4.8 - 18                                          | 3.9 - 15                                     |
| Field corn<br>(487 – including seed production)<br>(1800 - seed production)                                                    | 20               | 124 - 457                  | 15 - 57                                           | 12 - 46                                      |
|                                                                                                                                | 100              | 97 - 359                   | 12 - 45                                           | 10 - 36                                      |
|                                                                                                                                | 1000             | 28 - 105                   | 3.5 - 13                                          | 2.8 - 11                                     |
| Field pea, soybean<br>(625 - 1250)                                                                                             | 20               | 159 - 317                  | 20 - 39                                           | 16 - 32                                      |
|                                                                                                                                | 100              | 125 - 249                  | 15 - 31                                           | 12 - 25                                      |
|                                                                                                                                | 1000             | 36 - 73                    | 4.5 - 9.0                                         | 3.6 - 7.3                                    |
| Chickpea (desi and kabuli), dry<br>beans, snap beans, white bean,<br>lima bean, faba bean, lentils,<br>coloured beans<br>(625) | 20               | 159                        | 20                                                | 16                                           |
|                                                                                                                                | 100              | 125                        | 15                                                | 12                                           |
|                                                                                                                                | 1000             | 36                         | 4.5                                               | 3.6                                          |
| Crop group 4A – leafy greens<br>(140000)                                                                                       | 20               | 35551                      | 4405                                              | 3555                                         |
|                                                                                                                                | 100              | 27926                      | 3461                                              | 2793                                         |
|                                                                                                                                | 1000             | 8141                       | 1009                                              | 814                                          |
| Barley, wheat, oats<br>(100 – 300)                                                                                             | 20               | 25 - 76                    | 3.1 - 9.4                                         | 2.5 - 7.6                                    |
|                                                                                                                                | 100              | 20 - 60                    | 2.5 - 7.4                                         | 2.0 - 6.0                                    |
|                                                                                                                                | 1000             | 6 - 17                     | 0.74 - 2.1                                        | 0.60 - 1.7                                   |
| Crop group<br>5A – Broccoli and cabbage<br>(93333)                                                                             | 20               | 237001                     | 2937                                              | 2370                                         |
|                                                                                                                                | 100              | 18617                      | 2307                                              | 1862                                         |
|                                                                                                                                | 1000             | 5427                       | 673                                               | 543                                          |
| Crop group 9:<br>Summer squash (2500) cucumber<br>(pickles; 10000), citron melon<br>(2500), pumpkin (1000)                     | 20               | 254 - 2540                 | 32 - 315                                          | 25 - 254                                     |
|                                                                                                                                | 100              | 199 - 1995                 | 25 - 247                                          | 20 - 200                                     |
|                                                                                                                                | 1000             | 58 - 582                   | 7.2 - 72                                          | 5.8 - 58                                     |
| Tomato (4410)                                                                                                                  | 20               | 1120                       | 139                                               | 112                                          |

| Crop<br>(EEC: mg a.i./kg seed)                                                | Bird size<br>(g) | EDE<br>(mg a.i./kg bw/day) | RQ                                                |                                              |
|-------------------------------------------------------------------------------|------------------|----------------------------|---------------------------------------------------|----------------------------------------------|
|                                                                               |                  |                            | Acute HD <sub>5</sub> :<br>8.07 mg a.i./kg bw/day | Reproduction NOEL:<br>10.0 mg a.i./kg bw/day |
|                                                                               | 100              | 880                        | 109                                               | 88                                           |
|                                                                               | 1000             | 256                        | 32                                                | 26                                           |
| Crop group 8<br>(Pepper, 12450)                                               | 20               | 3162                       | 392                                               | 316                                          |
|                                                                               | 100              | 2483                       | 308                                               | 248                                          |
|                                                                               | 1000             | 724                        | 90                                                | 72                                           |
| Crop group 1B<br>(Parsnip, 4600)<br>(Carrot, 20700)                           | 20               | 1168 - 5257                | 145 - 651                                         | 117 - 526                                    |
|                                                                               | 100              | 918 - 4129                 | 114 - 512                                         | 92 - 413                                     |
|                                                                               | 1000             | 268 - 1204                 | 33 - 149                                          | 27 - 120                                     |
| Crop group 3<br>(Green Onion, 84000)<br>(Dry onion, 112000)<br>(Leek, 140000) | 20               | 2133 - 3555                | 264 - 441                                         | 213 - 356                                    |
|                                                                               | 100              | 1676 - 2793                | 208 - 346                                         | 168 - 279                                    |
|                                                                               | 1000             | 488 - 814                  | 61 - 101                                          | 488 - 81                                     |

Table 15 Seed treatment risk assessment for mammals (seed treatments shown to pose a potential risk are shown only)

| Crop<br>(EEC: mg a.i./kg seed)                                 | Mammal size<br>(g) | EDE<br>(mg a.i./kg/day) | RQ                                                    |                                              |
|----------------------------------------------------------------|--------------------|-------------------------|-------------------------------------------------------|----------------------------------------------|
|                                                                |                    |                         | Acute LD <sub>50</sub> /10:<br>37.9 mg a.i./kg bw/day | Reproduction NOEL:<br>18.9 mg a.i./kg bw/day |
| Canola mustard, Brown and<br>oriental mustard<br>(4000 - 8020) | 15                 | 580 - 1164              | 15 - 31                                               | 31 - 62                                      |
|                                                                | 35                 | 499 - 1001              | 13 - 26                                               | 26 - 53                                      |
|                                                                | 1000               | 275 - 551               | 7.3 - 15                                              | 15 - 29                                      |
| Sweet corn                                                     | 15                 | 98 - 363                | 2.5 - 10                                              | 5.2 - 19                                     |



| Crop<br>(EEC: mg a.i./kg seed)                                                                                                 | Mammal size<br>(g) | EDE<br>(mg a.i./kg/day) | RQ                                                    |                                              |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------|-------------------------------------------------------|----------------------------------------------|
|                                                                                                                                |                    |                         | Acute LD <sub>50</sub> /10:<br>37.9 mg a.i./kg bw/day | Reproduction NOEL:<br>18.9 mg a.i./kg bw/day |
| (675 – flea beetle,<br>2500 – wireworm)                                                                                        | 35                 | 84 – 312                | 2.2 – 8.2                                             | 4.4 – 17                                     |
|                                                                                                                                | 1000               | 46 – 172                | 1.2 – 4.5                                             | 2.4 – 9.1                                    |
| Field corn<br>(487 – including seed production)<br>(1800 – seed production)                                                    | 15                 | 71 – 261                | 1.9 – 6.9                                             | 3.8 – 14                                     |
|                                                                                                                                | 35                 | 61 – 225                | 1.6 – 5.9                                             | 3.2 – 12                                     |
|                                                                                                                                | 1000               | 34 – 124                | 0.90 – 3.3                                            | 1.8 – 6.6                                    |
| Field pea, soybean<br>(625 – 1250)                                                                                             | 15                 | 91 – 181                | 2.4 – 4.8                                             | 4.8 – 10                                     |
|                                                                                                                                | 35                 | 78 – 156                | 2.1 – 4.1                                             | 4.1 – 8.3                                    |
|                                                                                                                                | 1000               | 43 – 86                 | 1.1 – 2.3                                             | 2.3 – 4.6                                    |
| Chickpea (desi and kabuli), dry<br>beans, snap beans, white bean,<br>lima bean, faba bean, lentils,<br>coloured beans<br>(625) | 15                 | 91                      | 2.4                                                   | 4.8                                          |
|                                                                                                                                | 35                 | 78                      | 2.1                                                   | 4.1                                          |
|                                                                                                                                | 1000               | 43                      | 1.1                                                   | 2.3                                          |
| Crop group 4A – leafy greens<br>(140000)                                                                                       | 15                 | 20317                   | 536                                                   | 1075                                         |
|                                                                                                                                | 35                 | 17472                   | 461                                                   | 925                                          |
|                                                                                                                                | 1000               | 9620                    | 254                                                   | 509                                          |
| Barley, wheat, oats<br>(100 – 300)                                                                                             | 15                 | 15 – 44                 | 0.40 – 1.2                                            | 0.79 – 2.3                                   |
|                                                                                                                                | 35                 | 12 – 37                 | 0.32 – 0.98                                           | 0.63 – 2.0                                   |
|                                                                                                                                | 1000               | 7 – 21                  | 0.18 – 0.55                                           | 0.37 – 1.1                                   |
| Crop group<br>5A – Broccoli and cabbage<br>(93333)                                                                             | 15                 | 13544                   | 357                                                   | 717                                          |
|                                                                                                                                | 35                 | 11648                   | 307                                                   | 616                                          |
|                                                                                                                                | 1000               | 6414                    | 169                                                   | 339                                          |
| Crop group 9:<br>Summer squash (2500) cucumber<br>(pickles; 10000), citron melon<br>(2500), pumpkin (1000)                     | 15                 | 145 – 1451              | 3.8 – 38                                              | 7.7 – 77                                     |
|                                                                                                                                | 35                 | 125 – 1248              | 3.3 – 33                                              | 6.6 – 66                                     |
|                                                                                                                                | 1000               | 69 – 687                | 1.8 – 18                                              | 3.6 – 36                                     |
| Crop group 8<br>Tomato (4410)                                                                                                  | 15                 | 640                     | 17                                                    | 34                                           |
|                                                                                                                                | 35                 | 550                     | 15                                                    | 29                                           |
|                                                                                                                                | 1000               | 303                     | 8.0                                                   | 16                                           |
| Crop group 8<br>(Pepper, 12450)                                                                                                | 15                 | 1807                    | 48                                                    | 96                                           |
|                                                                                                                                | 35                 | 1554                    | 41                                                    | 82                                           |

| Crop<br>(EEC: mg a.i./kg seed)       | Mammal size<br>(g) | EDE<br>(mg a.i./kg/day) | RQ                                                    |                                              |
|--------------------------------------|--------------------|-------------------------|-------------------------------------------------------|----------------------------------------------|
|                                      |                    |                         | Acute LD <sub>50</sub> /10:<br>37.9 mg a.i./kg bw/day | Reproduction NOEL:<br>18.9 mg a.i./kg bw/day |
|                                      | 1000               | 856                     | 23                                                    | 45                                           |
| Crop group 1B<br>(Parsnip, 4600)     | 15                 | 668 – 3004              | 18 – 79                                               | 35 – 159                                     |
| (Carrots, 20700)                     | 35                 | 574 – 2583              | 15 – 68                                               | 30 – 137                                     |
|                                      | 1000               | 316 – 1422              | 8.3 – 38                                              | 17 – 75                                      |
| Crop group 3<br>(Green Onion, 84000) | 15                 | 1219 – 2032             | 32 – 54                                               | 65 – 108                                     |
| (Dry onion, 112000)                  | 35                 | 1048 – 1747             | 28 – 46                                               | 56 – 92                                      |
| (Leek, 140000)                       | 1000               | 577 – 962               | 15 – 25                                               | 31 – 51                                      |

**Table 16 The number of seeds treated with imidacloprid required to reach the bird acute and reproductive endpoint and foraging area required to reach the endpoints**

| Crop<br>(EEC: mg a.i./kg seed)                     | Bird size<br>(g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|----------------------------------------------------|------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                                    |                  | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| Canola mustard<br>(High rate - 8020)               | 20               | 11                                                         | 0.5 – 1.4                                    | 13                                                         | 0.7 – 1.7                                    |
|                                                    | 100              | 53                                                         | 2.7 – 6.8                                    | 66                                                         | 3.4 – 8.4                                    |
|                                                    | 1000             | 532                                                        | 27 – 68                                      | 660                                                        | 34 – 84                                      |
| Canola mustard<br>(Low rate - 4000)                | 20               | 21                                                         | 1.1 – 2.7                                    | 26                                                         | 1.4 – 3.4                                    |
|                                                    | 100              | 107                                                        | 5.5 – 14                                     | 132                                                        | 6.8 – 17                                     |
|                                                    | 1000             | 1067                                                       | 55 – 136                                     | 1323                                                       | 68 – 168                                     |
| Mustard – Brown and oriental<br>(High rate – 8000) | 20               | 7.4                                                        | 0.6 – 1.4                                    | 9                                                          | 0.7 – 1.7                                    |
|                                                    | 100              | 37                                                         | 2.7 – 6.8                                    | 46                                                         | 3.4 – 8.4                                    |
|                                                    | 1000             | 372                                                        | 27 – 68                                      | 461                                                        | 34 – 84                                      |
| Mustard – Brown and oriental<br>(Low rate – 4000)  | 20               | 15                                                         | 1.1 – 2.7                                    | 18                                                         | 1.4 – 3.4                                    |
|                                                    | 100              | 74                                                         | 5.5 – 14                                     | 92                                                         | 6.8 – 17                                     |
|                                                    | 1000             | 744                                                        | 55 – 136                                     | 922                                                        | 68 – 168                                     |
| Field corn<br>(487 – including seed production)    | 20               | 1.0                                                        | 21 – 32                                      | 1.2                                                        | 26 – 39                                      |
|                                                    | 100              | 5.0                                                        | 105 – 158                                    | 6.2                                                        | 130 – 195                                    |
|                                                    | 1000             | 50                                                         | 1050 – 1577                                  | 62                                                         | 1301 – 1954                                  |
| Field corn                                         | 20               | 0.3                                                        | 5.7 – 8.5                                    | 0.3                                                        | 7.1 – 11                                     |

| Crop<br>(EEC: mg a.i./kg seed)      | Bird size<br>(g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|-------------------------------------|------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                     |                  | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| (1800 - seed production only)       | 100              | 1.4                                                        | 28 - 43                                      | 1.7                                                        | 35 - 53                                      |
|                                     | 1000             | 13                                                         | 284 - 427                                    | 17                                                         | 352 - 529                                    |
| Sweet corn<br>(2500 - flea beetle)  | 20               | 0.3 - 0.5                                                  | 4.3 - 49                                     | 0.3 - 0.6                                                  | 11 - 30                                      |
|                                     | 100              | 1.3 - 2.6                                                  | 43 - 123                                     | 1.6 - 3.2                                                  | 53 - 152                                     |
|                                     | 1000             | 13 - 26                                                    | 427 - 1230                                   | 16 - 32                                                    | 529 - 1524                                   |
| Sweet corn<br>(675 - wireworm)      | 20               | 1.0 - 1.9                                                  | 16 - 182                                     | 1.2 - 2.4                                                  | 39 - 113                                     |
|                                     | 100              | 4.8 - 9.6                                                  | 158 - 455                                    | 5.9 - 12                                                   | 196 - 564                                    |
|                                     | 1000             | 48 - 96                                                    | 1581 - 4555                                  | 59 - 119                                                   | 1959 - 5643                                  |
| Field pea<br>(1250)                 | 20               | 0.4 - 1.0                                                  | 0.1 - 0.8                                    | 0.5 - 1.3                                                  | 0.3 - 0.4                                    |
|                                     | 100              | 1.9 - 5.2                                                  | 1.0 - 1.5                                    | 2.4 - 6.4                                                  | 1.2 - 1.9                                    |
|                                     | 1000             | 19 - 52                                                    | 10 - 15                                      | 24 - 64                                                    | 12 - 19                                      |
| Field pea<br>(625)                  | 20               | 0.8 - 2.1                                                  | 0.2 - 1.6                                    | 1.0 - 2.6                                                  | 0.5 - 0.8                                    |
|                                     | 100              | 3.9 - 10                                                   | 2.0 - 3.1                                    | 4.8 - 13                                                   | 2.5 - 3.8                                    |
|                                     | 1000             | 39 - 103                                                   | 20 - 31                                      | 48 - 128                                                   | 25 - 38                                      |
| Soybean<br>(625)                    | 20               | 1.4 - 1.9                                                  | 0.5 - 1.9                                    | 1.8 - 2.4                                                  | 0.8 - 1.7                                    |
|                                     | 100              | 7.1 - 9.6                                                  | 3.1 - 6.9                                    | 8.8 - 12                                                   | 3.9 - 8.5                                    |
|                                     | 1000             | 71 - 96                                                    | 31 - 69                                      | 88 - 118                                                   | 38 - 85                                      |
| Soybean<br>(1250)                   | 20               | 0.7 - 1.0                                                  | 0.2 - 0.9                                    | 0.9 - 1.2                                                  | 0.4 - 0.9                                    |
|                                     | 100              | 3.6 - 4.8                                                  | 1.6 - 3.4                                    | 4.4 - 5.9                                                  | 1.9 - 4.3                                    |
|                                     | 1000             | 36 - 48                                                    | 16 - 34                                      | 44 - 59                                                    | 19 - 43                                      |
| Chickpea - desi and kabuli<br>(625) | 20               | 0.8                                                        | 0.5 - 0.6                                    | 1.0                                                        | 0.6 - 0.7                                    |
|                                     | 100              | 3.9                                                        | 2.5 - 2.9                                    | 4.8                                                        | 3.1 - 3.6                                    |
|                                     | 1000             | 39                                                         | 25 - 29                                      | 48                                                         | 31 - 36                                      |
| Dry beans<br>(625)                  | 20               | 0.8 - 1.3                                                  | 0.6 - 4.1                                    | 1.0 - 1.6                                                  | 1.2 - 3.0                                    |
|                                     | 100              | 3.9 - 6.5                                                  | 4.7 - 12                                     | 4.8 - 8.0                                                  | 5.8 - 15                                     |
|                                     | 1000             | 39 - 65                                                    | 47 - 122                                     | 48 - 80                                                    | 58 - 152                                     |
| Snap beans<br>(625)                 | 20               | 0.5 - 0.8                                                  | 0.3 - 1.5                                    | 0.6 - 1.0                                                  | 0.6 - 1.2                                    |
|                                     | 100              | 2.6 - 3.9                                                  | 2.4 - 4.9                                    | 3.2 - 4.8                                                  | 2.9 - 6.1                                    |
|                                     | 1000             | 26 - 39                                                    | 24 - 49                                      | 32 - 48                                                    | 29 - 61                                      |
| White bean<br>(625)                 | 20               | 0.8 - 1.3                                                  | 0.6 - 4.1                                    | 1.0 - 1.6                                                  | 1.2 - 3.0                                    |
|                                     | 100              | 3.9 - 6.5                                                  | 4.7 - 12                                     | 4.8 - 8.0                                                  | 5.8 - 15                                     |
|                                     | 1000             | 39 - 65                                                    | 47 - 122                                     | 48 - 80                                                    | 58 - 152                                     |

| Crop<br>(EEC: mg a.i./kg seed)                        | Bird size<br>(g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|-------------------------------------------------------|------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                                       |                  | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| Lima bean<br>(625)                                    | 20               | 0.3 – 0.4                                                  | 0.6 – 4.0                                    | 0.3 – 0.5                                                  | 1.1 – 3.4                                    |
|                                                       | 100              | 1.3 – 1.9                                                  | 4.5 – 14                                     | 1.6 – 2.4                                                  | 5.6 – 17                                     |
|                                                       | 1000             | 13 – 19                                                    | 45 – 136                                     | 16 – 24                                                    | 56 – 168                                     |
| Faba bean<br>(625)                                    | 20               | 0.3 – 0.5                                                  | 0.1 – 0.6                                    | 0.3 – 0.6                                                  | 0.3 – 0.4                                    |
|                                                       | 100              | 1.3 – 2.6                                                  | 1.1 – 1.5                                    | 1.6 – 3.2                                                  | 1.3 – 1.8                                    |
|                                                       | 1000             | 13 – 26                                                    | 11 – 15                                      | 16 – 32                                                    | 13 – 18                                      |
| Lentils<br>(625)                                      | 20               | 3.1 – 8.5                                                  | 0.3 – 4.8                                    | 3.8 – 11                                                   | 1.1 – 2.2                                    |
|                                                       | 100              | 15 – 43                                                    | 4.4 – 8.7                                    | 19 – 53                                                    | 5.4 – 11                                     |
|                                                       | 1000             | 155 – 426                                                  | 43 – 87                                      | 192 – 528                                                  | 54 – 108                                     |
| Coloured beans<br>(625)                               | 20               | 0.8 – 1.3                                                  | 0.8 – 4.1                                    | 1.0 – 1.6                                                  | 1.6 – 3.0                                    |
|                                                       | 100              | 3.9 – 6.5                                                  | 6.3 – 12                                     | 4.8 – 8.0                                                  | 7.8 – 15                                     |
|                                                       | 1000             | 39 – 65                                                    | 63 – 122                                     | 48 – 80                                                    | 78 – 152                                     |
| Crop group 4A<br>leafy greens<br>(140000)             | 20               | 0.8                                                        | 0.2 – 0.4                                    | 1.0                                                        | 0.2 – 0.4                                    |
|                                                       | 100              | 4.0                                                        | 0.9 – 1.8                                    | 5.0                                                        | 1.1 – 2.2                                    |
|                                                       | 1000             | 40                                                         | 8.7 – 17                                     | 50                                                         | 11 – 22                                      |
| Barley, wheat, oats <sup>3</sup><br>(High rate – 300) | 20               | 12 – 18                                                    | 1.0 – 4.6                                    | 14 – 22                                                    | 1.2 – 5.6                                    |
|                                                       | 100              | 59 – 89                                                    | 4.8 – 23                                     | 73 – 110                                                   | 5.9 – 28                                     |
|                                                       | 1000             | 592 – 888                                                  | 48 – 227                                     | 733 – 1100                                                 | 59 – 282                                     |
| Barley, wheat, oats <sup>3</sup><br>(Low rate – 100)  | 20               | 36 – 53                                                    | 2.8 – 14                                     | 44 – 66                                                    | 3.5 – 17                                     |
|                                                       | 100              | 178 – 266                                                  | 14 – 68                                      | 220 – 330                                                  | 18 – 84                                      |
|                                                       | 1000             | 1775 – 2663                                                | 143 – 681                                    | 2200 – 3300                                                | 177 – 8455                                   |
| Crop group 5A<br>Broccoli and cabbage<br>(93333)      | 20               | 0.5                                                        | 1.5 – 1.9                                    | 0.7                                                        | 1.9 – 2.4                                    |
|                                                       | 100              | 2.7                                                        | 7.5 – 9.7                                    | 3.3                                                        | 9.3 – 12                                     |
|                                                       | 1000             | 27                                                         | 75 – 97                                      | 33                                                         | 93 – 120                                     |
| Crop group 9<br>Cucumber (pickles, 10000)             | 20               | 0.7                                                        | 7.1 – 11                                     | 0.8                                                        | 8.8 – 13                                     |
|                                                       | 100              | 3.2                                                        | 35 – 53                                      | 4.0                                                        | 44 – 66                                      |
|                                                       | 1000             | 32                                                         | 354 – 531                                    | 40                                                         | 439 – 658                                    |
| Crop group 9<br>Summer squash (2500)                  | 20               | 0.7                                                        | 18 – 89                                      | 0.8                                                        | 22 – 110                                     |
|                                                       | 100              | 3.2                                                        | 89 – 444                                     | 4.0                                                        | 110 – 550                                    |
|                                                       | 1000             | 32                                                         | 889 – 4446                                   | 40                                                         | 1102 – 5510                                  |
| Crop group 9<br>Pumpkin (1000)                        | 20               | 0.7                                                        | 17 – 87                                      | 0.8                                                        | 22 – 108                                     |
|                                                       | 100              | 3.2                                                        | 87 – 436                                     | 4.0                                                        | 108 – 541                                    |
|                                                       | 1000             | 32                                                         | 873 – 4366                                   | 40                                                         | 1082 – 5411                                  |



| Crop<br>(EEC: mg a.i./kg seed)      | Bird size<br>(g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|-------------------------------------|------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                     |                  | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| Crop group 9<br>Citron melon (2500) | 20               | 0.7                                                        | 32 – 59                                      | 0.8                                                        | 39 – 73                                      |
|                                     | 100              | 3.2                                                        | 158 – 296                                    | 4.0                                                        | 196 – 367                                    |
|                                     | 1000             | 32                                                         | 1578 – 2964                                  | 40                                                         | 1955 – 3673                                  |
| Crop group 8<br>Tomato (4410)       | 20               | 13                                                         | 10 – 246                                     | 16                                                         | 12 – 305                                     |
|                                     | 100              | 64                                                         | 50 – 1232                                    | 79                                                         | 62 – 1527                                    |
|                                     | 1000             | 640                                                        | 504 – 12323                                  | 794                                                        | 625 – 15270                                  |
| Crop group 8<br>Peppers (12450)     | 20               | 1.9                                                        | 20                                           | 2.4                                                        | 24                                           |
|                                     | 100              | 9.7                                                        | 98                                           | 12                                                         | 122                                          |
|                                     | 1000             | 97                                                         | 982                                          | 120                                                        | 1217                                         |
| Crop group 1B<br>Parsnips (4600)    | 20               | 7.0                                                        | 1.9 – 3.5                                    | 8.7                                                        | 2.4 – 4.4                                    |
|                                     | 100              | 35                                                         | 9.7 – 18                                     | 43                                                         | 12 – 22                                      |
|                                     | 1000             | 351                                                        | 97 – 177                                     | 435                                                        | 120 – 220                                    |
| Crop group 1B<br>Carrots (20700)    | 20               | 7.0                                                        | 0.5 – 2.4                                    | 8.7                                                        | 0.7 – 2.9                                    |
|                                     | 100              | 35                                                         | 2.6 – 12                                     | 43                                                         | 3.3 – 15                                     |
|                                     | 1000             | 351                                                        | 26 – 118                                     | 435                                                        | 33 – 146                                     |
| Crop group 3<br>Green onion (8400)  | 20               | 5.4                                                        | 0.8                                          | 6.7                                                        | 1.0                                          |
|                                     | 100              | 27                                                         | 4.2                                          | 33                                                         | 5.2                                          |
|                                     | 1000             | 269                                                        | 42                                           | 333                                                        | 52                                           |
| Crop group 3<br>Dry onion (11200)   | 20               | 4.0                                                        | 1.0 – 1.1                                    | 5.0                                                        | 1.2 – 1.4                                    |
|                                     | 100              | 20                                                         | 4.9 – 5.5                                    | 25                                                         | 6.0 – 6.8                                    |
|                                     | 1000             | 202                                                        | 49 – 55                                      | 250                                                        | 60 – 68                                      |
| Crop group 3<br>Leeks (14000)       | 20               | 4.0                                                        | 1.6 – 3.2                                    | 5                                                          | 2.0 – 3.9                                    |
|                                     | 100              | 20                                                         | 7.9 – 16                                     | 25                                                         | 9.8 – 20                                     |
|                                     | 1000             | 202                                                        | 79 – 159                                     | 250                                                        | 6.5 – 197                                    |

<sup>1</sup> minimum to maximum number of seeds to reach endpoint based on seed size range (maximum to minimum)

<sup>2</sup> minimum and maximum area required based on minimum and maximum seeding rate

<sup>3</sup> The number of seeds to reach the endpoint and foraging distance required to achieve the endpoint is based on oats; wheat, barley and oats have been grouped together as the seed size and seeding rate range for each are very similar. The number seeds to reach the endpoints, and the required foraging distance to achieve the endpoint, are expected to be similar for each of these three seed crops.

**Table 17 Comparison of the estimated number of treated seeds to reach acute and reproductive endpoints for birds to the number of seeds observed consumed in the field**

| Crop<br>(EEC: mg a.i./kg seed)  | Bird size (g) | Acute                                                | Reproduction                                         | Field data <sup>2</sup>         |                                 |                         |
|---------------------------------|---------------|------------------------------------------------------|------------------------------------------------------|---------------------------------|---------------------------------|-------------------------|
|                                 |               | # seeds to reach endpoint (min to max.) <sup>1</sup> | # seeds to reach endpoint (min to max.) <sup>1</sup> | Mean # seeds consumed per visit | Max. # seeds consumed per visit | # species (% dehusking) |
| Canola mustard (8020)           | 20            | 11                                                   | 13                                                   | 36 - 104                        | 85 - 240                        | 3 (43 - 100)            |
|                                 | 100           | 53                                                   | 66                                                   | NI                              |                                 |                         |
|                                 | 1000          | 532                                                  | 660                                                  | 214 - 2201                      | 361 - 4887                      | 2                       |
| Canola mustard (4000)           | 20            | 21                                                   | 26                                                   | 36 - 104                        | 85 - 240                        | 3 (43 - 100)            |
|                                 | 100           | 107                                                  | 132                                                  | NI                              |                                 |                         |
|                                 | 1000          | 1067                                                 | 1323                                                 | 214 - 2201                      | 361 - 4887                      | 2                       |
| Sweet corn (2500 - flea beetle) | 20            | 0.3 - 0.5                                            | 0.3 - 0.6                                            | 3 - 4                           | 4 - 11                          | 3                       |
|                                 | 100           | 1.3 - 2.6                                            | 1.6 - 3.2                                            | 5 - 10                          | 15 - 20                         | 2                       |
|                                 | 1000          | 13 - 26                                              | 16 - 32                                              | 5 - 92                          | 12 - 266                        | 5                       |
| Sweet corn (675 - wireworm)     | 20            | 1.0 - 1.9                                            | 1.2 - 2.4                                            | 3 - 4                           | 10 - 11                         | 3                       |
|                                 | 100           | 4.8 - 9.6                                            | 5.9 - 12                                             | 5 - 10                          | 15 - 20                         | 2                       |
|                                 | 1000          | 48 - 96                                              | 59 - 119                                             | 5 - 92                          | 12 - 266                        | 5                       |
| Field pea (1250)                | 20            | 0.4 - 1.0                                            | 0.5 - 1.3                                            | 1                               | 2                               | 1                       |
|                                 | 100           | 1.9 - 5.2                                            | 2.4 - 6.4                                            | 1                               | 1                               | 1                       |
|                                 | 1000          | 19 - 52                                              | 24 - 64                                              | 3 - 31                          | 4 - 113                         | 4                       |
| Field pea (625)                 | 20            | 0.8 - 2.1                                            | 1.0 - 2.6                                            | 1                               | 2                               | 1                       |
|                                 | 100           | 3.9 - 10                                             | 4.8 - 13                                             | 1                               | 1                               | 1                       |
|                                 | 1000          | 39 - 103                                             | 48 - 128                                             | 3 - 31                          | 4 - 113                         | 4                       |
| Barley (spring) (300)           | 20            | 12 - 18                                              | 14 - 22                                              | 1 - 18                          | 1 - 53                          | 12 (0 - 100)            |
|                                 | 100           | 59 - 89                                              | 73 - 110                                             | 2 - 20                          | 2 - 37                          | 4                       |
|                                 | 1000          | 592 - 888                                            | 733 - 1100                                           | 4 - 144                         | 10 - 328                        | 6                       |
| Barley (spring) (100)           | 20            | 36 - 53                                              | 44 - 66                                              | 1 - 18                          | 1 - 53                          | 12 (0 - 100)            |
|                                 | 100           | 178 - 266                                            | 220 - 330                                            | 2 - 20                          | 2 - 37                          | 4                       |
|                                 | 1000          | 1775 - 2663                                          | 2200 - 3300                                          | 4 - 144                         | 10 - 328                        | 6                       |
| Wheat (300)                     | 20            | 12 - 18                                              | 14 - 22                                              | 2 - 19                          | 4 - 74                          | 11 (0 - 100)            |
|                                 | 100           | 59 - 89                                              | 73 - 110                                             | 1 - 45                          | 1 - 90                          | 6                       |
|                                 | 1000          | 592 - 888                                            | 733 - 1100                                           | 28 - 126                        | 128 - 392                       | 4                       |
| Wheat (100)                     | 20            | 36 - 53                                              | 44 - 66                                              | 2 - 19                          | 4 - 74                          | 11 (0 - 100)            |
|                                 | 100           | 178 - 266                                            | 220 - 330                                            | 1 - 45                          | 1 - 90                          | 6                       |
|                                 | 1000          | 1775 - 2663                                          | 2200 - 3300                                          | 28 - 126                        | 128 - 392                       | 4                       |

| Crop<br>(EEC: mg a.i./kg seed) | Bird size (g) | Acute                                                | Reproduction                                         | Field data <sup>2</sup>         |                                 |                         |
|--------------------------------|---------------|------------------------------------------------------|------------------------------------------------------|---------------------------------|---------------------------------|-------------------------|
|                                |               | # seeds to reach endpoint (min to max.) <sup>1</sup> | # seeds to reach endpoint (min to max.) <sup>1</sup> | Mean # seeds consumed per visit | Max. # seeds consumed per visit | # species (% dehusking) |
| Oat (300)                      | 20            | 12 - 18                                              | 14 - 22                                              | 6 - 11                          | 10 - 46                         | 3                       |
|                                | 100           | 59 - 89                                              | 73 - 110                                             | 2 - 13                          | 3 - 67                          | 3                       |
|                                | 1000          | 592 - 888                                            | 733 - 1100                                           | NI                              |                                 |                         |
| Oat (100)                      | 20            | 36 - 53                                              | 44 - 66                                              | 6 - 11                          | 10 - 46                         | 3                       |
|                                | 100           | 178 - 266                                            | 220 - 330                                            | 2 - 13                          | 3 - 67                          | 3                       |
|                                | 1000          | 1775 - 2663                                          | 2200 - 3300                                          | NI                              |                                 |                         |

NI = no information.

<sup>1</sup> Minimum to maximum number of seeds to reach endpoint based on seed size range (maximum to minimum). The number of seeds to reach the endpoint for barley and wheat was determined based on the seed size for oats; as the seed size for barley, wheat and oat are very similar, the number of seeds to reach the endpoint for oats is considered representative of that for barley and wheat.

<sup>2</sup> The seed preference data (i.e., mean and max # seeds consumed per visit) is representative of bird species ranging in weight from 18 to 30g (small sized birds), 80 to 125g (medium birds) and 450 to >1000g (large birds), for the 20, 100 and 1000 bird size categories, respectively (data from Prosser and Hart 2005 (PMRA 2574060) and Smith 2006 (PMRA 2541662)).

**Table 18 The number of seeds treated with imidacloprid required to reach the mammalian acute and reproductive endpoint and foraging area required to reach the endpoints**

| Crop<br>(EEC: mg a.i./kg seed)                  | Mammal size (g) | Acute                                                |                                              | Reproduction                                         |                                              |
|-------------------------------------------------|-----------------|------------------------------------------------------|----------------------------------------------|------------------------------------------------------|----------------------------------------------|
|                                                 |                 | # seeds to reach endpoint (min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach endpoint (min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| Canola mustard (8020)                           | 15              | 38                                                   | 1.9 - 4.8                                    | 19                                                   | 1.0 - 2.4                                    |
|                                                 | 35              | 88                                                   | 4.5 - 11                                     | 44                                                   | 2.2 - 5.6                                    |
|                                                 | 1000            | 2500                                                 | 128 - 318                                    | 1247                                                 | 64 - 159                                     |
| Canola mustard (Low rate - 4000)                | 15              | 75                                                   | 3.9 - 9.6                                    | 38                                                   | 1.9 - 4.8                                    |
|                                                 | 35              | 175                                                  | 9.0 - 22                                     | 87                                                   | 4.5 - 11                                     |
|                                                 | 1000            | 5013                                                 | 256 - 638                                    | 2500                                                 | 128 - 318                                    |
| Mustard - Brown and oriental (High rate - 8000) | 15              | 26                                                   | 1.9 - 4.8                                    | 13                                                   | 1.0 - 2.4                                    |
|                                                 | 35              | 61                                                   | 4.5 - 11                                     | 31                                                   | 2.2 - 5.6                                    |
|                                                 | 1000            | 1748                                                 | 128 - 319                                    | 872                                                  | 64 - 159                                     |
| Mustard - Brown and oriental (Low rate - 4000)  | 15              | 52                                                   | 3.9 - 9.6                                    | 26                                                   | 1.9 - 4.8                                    |
|                                                 | 35              | 122                                                  | 9.0 - 22                                     | 61                                                   | 4.5 - 11                                     |
|                                                 | 1000            | 3496                                                 | 256 - 638                                    | 1744                                                 | 128 - 318                                    |

| Crop<br>(EEC: mg a.i./kg seed)                        | Mammal<br>size (g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|-------------------------------------------------------|--------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                                       |                    | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| Field corn<br>(487 – including seed production)       | 15                 | 3.5                                                        | 74 – 111                                     | 1.7                                                        | 37 – 55                                      |
|                                                       | 35                 | 8.2                                                        | 173 – 259                                    | 4.1                                                        | 86 – 129                                     |
|                                                       | 1000               | 233                                                        | 4931 – 7404                                  | 116                                                        | 2459 – 3692                                  |
| Field corn<br>(1800 – seed production only)           | 15                 | 1.0                                                        | 20 – 30                                      | 0.5                                                        | 10 – 15                                      |
|                                                       | 35                 | 2.2                                                        | 47 – 70                                      | 1.1                                                        | 23 – 35                                      |
|                                                       | 1000               | 63                                                         | 1335 – 2005                                  | 32                                                         | 666 – 1000                                   |
| Sweet corn<br>(2500 – flea beetle)                    | 15                 | 0.9 – 1.89                                                 | 30 – 87                                      | 0.5 – 0.9                                                  | 15 – 43                                      |
|                                                       | 35                 | 2.1 – 4.2                                                  | 70 – 202                                     | 1.1 – 2.1                                                  | 35 – 101                                     |
|                                                       | 1000               | 61 – 121                                                   | 2004 – 5775                                  | 30 – 60                                                    | 1000 – 2880                                  |
| Sweet corn<br>(675 – wireworm)                        | 15                 | 3.4 – 6.7                                                  | 111 – 321                                    | 1.7 – 3.4                                                  | 56 – 160                                     |
|                                                       | 35                 | 7.9 – 16                                                   | 260 – 749                                    | 3.9 – 7.8                                                  | 130 – 373                                    |
|                                                       | 1000               | 225 – 449                                                  | 7425 – 21390                                 | 112 – 224                                                  | 3702 – 10667                                 |
| Field pea<br>(1250)                                   | 15                 | 1.4 – 3.6                                                  | 0.7 – 1.1                                    | 0.7 – 1.8                                                  | 0.4 – 0.5                                    |
|                                                       | 35                 | 3.2 – 8.5                                                  | 1.6 – 2.5                                    | 1.6 – 4.2                                                  | 0.8 – 1.3                                    |
|                                                       | 1000               | 91 – 243                                                   | 47 – 72                                      | 45 – 121                                                   | 23 – 36                                      |
| Field pea<br>(625)                                    | 15                 | 2.7 – 7.3                                                  | 1.4 – 2.2                                    | 1.4 – 3.6                                                  | 0.7 – 1.1                                    |
|                                                       | 35                 | 6.4 – 17                                                   | 3.3 – 5.0                                    | 3.2 – 8.5                                                  | 1.6 – 2.5                                    |
|                                                       | 1000               | 182 – 485                                                  | 93 – 144                                     | 91 – 242                                                   | 47 – 72                                      |
| Soybean<br>(625)                                      | 15                 | 5 – 6.7                                                    | 2.2 – 4.8                                    | 2.5 – 3.4                                                  | 1.1 – 2.4                                    |
|                                                       | 35                 | 12 – 16                                                    | 5.1 – 11                                     | 5.8 – 7.8                                                  | 2.6 – 5.6                                    |
|                                                       | 1000               | 334 – 449                                                  | 146 – 322                                    | 166 – 224                                                  | 73 – 161                                     |
| Soybean (1250)                                        | 15                 | 2.5 – 3.4                                                  | 1. – 2.4                                     | 1.3 – 1.7                                                  | 0.6 – 1.2                                    |
|                                                       | 35                 | 5.8 – 7.9                                                  | 2.6 – 5.6                                    | 2.9 – 3.9                                                  | 1.3 – 2.8                                    |
|                                                       | 1000               | 167 – 224                                                  | 73 – 161                                     | 83 – 112                                                   | 36 – 80                                      |
| Chickpea – desi and kabuli<br>(625) Standard drilling | 15                 | 2.7                                                        | 1.8 – 2.0                                    | 1.4                                                        | 0.9 – 1.0                                    |
|                                                       | 35                 | 6.4                                                        | 4.1 – 4.8                                    | 3.2                                                        | 2.1 – 2.4                                    |
|                                                       | 1000               | 181                                                        | 118 – 136                                    | 91                                                         | 59 – 68                                      |
| Dry beans<br>(625)                                    | 15                 | 2.7 – 4.6                                                  | 3.3 – 8.6                                    | 2.3 – 1.4                                                  | 1.7 – 4.3                                    |
|                                                       | 35                 | 6.4 – 11                                                   | 7.8 – 20                                     | 3.2 – 5.3                                                  | 3.9 – 10                                     |
|                                                       | 1000               | 182 – 303                                                  | 221 – 574                                    | 91 – 151                                                   | 110 – 287                                    |
| Snap beans<br>(625)                                   | 15                 | 1.8 – 2.7                                                  | 1.7 – 3.5                                    | 0.9 – 1.4                                                  | 0.8 – 1.7                                    |
|                                                       | 35                 | 4.2 – 6.4                                                  | 3.9 – 8.0                                    | 2.1 – 3.2                                                  | 1.9 – 4.0                                    |
|                                                       | 1000               | 121 – 182                                                  | 111 – 230                                    | 60 – 91                                                    | 56 – 115                                     |



| Crop<br>(EEC: mg a.i./kg seed)                        | Mammal<br>size (g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|-------------------------------------------------------|--------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                                       |                    | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| White bean<br>(625)                                   | 15                 | 2.7 - 4.6                                                  | 3.3 - 8.6                                    | 1.4 - 2.3                                                  | 1.7 - 4.3                                    |
|                                                       | 35                 | 6.0 - 11                                                   | 7.8 - 20                                     | 3.2 - 5.3                                                  | 3.9 - 10                                     |
|                                                       | 1000               | 182 - 303                                                  | 221 - 574                                    | 91 - 151                                                   | 110 - 286                                    |
| Lima bean<br>(625)                                    | 15                 | 0.9 - 1.4                                                  | 3.2 - 9.6                                    | 0.5 - 0.7                                                  | 1.6 - 4.8                                    |
|                                                       | 35                 | 2.1 - 3.2                                                  | 7.4 - 22                                     | 1.1 - 1.6                                                  | 3.7 - 11                                     |
|                                                       | 1000               | 61 - 91                                                    | 213 - 638                                    | 30 - 45                                                    | 106 - 318                                    |
| Faba bean<br>(625)                                    | 15                 | 0.9 - 1.8                                                  | 0.7 - 1.0                                    | 0.5 - 0.9                                                  | 0.4 - 0.5                                    |
|                                                       | 35                 | 2.1 - 4.2                                                  | 1.7 - 2.4                                    | 1.1 - 2.1                                                  | 0.9 - 1.2                                    |
|                                                       | 1000               | 61 - 121                                                   | 49 - 69                                      | 30 - 60                                                    | 25 - 34                                      |
| Lentils<br>(625)                                      | 15                 | 11 - 30                                                    | 3.1 - 6.1                                    | 5 - 15                                                     | 1.5 - 3.1                                    |
|                                                       | 35                 | 25 - 70                                                    | 7.2 - 14                                     | 13 - 35                                                    | 3.6 - 7.1                                    |
|                                                       | 1000               | 727 - 2001                                                 | 204 - 408                                    | 363 - 998                                                  | 102 - 204                                    |
| Coloured beans<br>(625)                               | 15                 | 2.7 - 4.6                                                  | 4.5 - 8.6                                    | 1.4 - 2.3                                                  | 2.2 - 4.3                                    |
|                                                       | 35                 | 6.4 - 11                                                   | 10 - 20                                      | 3.2 - 5.3                                                  | 5.2 - 10                                     |
|                                                       | 1000               | 182 - 303                                                  | 297 - 574                                    | 91 - 151                                                   | 148 - 286                                    |
| Crop group 4A - leafy greens<br>(140000)              | 15                 | 2.8                                                        | 0.6 - 1.2                                    | 1.4                                                        | 0.3 - 0.6                                    |
|                                                       | 35                 | 6.6                                                        | 1.4 - 2.9                                    | 3.3                                                        | 0.7 - 1.4                                    |
|                                                       | 1000               | 190                                                        | 41 - 82                                      | 95                                                         | 20 - 41                                      |
| Barley, wheat, oats <sup>3</sup><br>(High rate - 300) | 15                 | 42 - 63                                                    | 5.0 - 11                                     | 31 - 20                                                    | 2.5 - 5.3                                    |
|                                                       | 35                 | 97 - 146                                                   | 12 - 25                                      | 73 - 49                                                    | 5.9 - 12                                     |
|                                                       | 1000               | 2779 - 4169                                                | 335 - 712                                    | 2079 - 1386                                                | 355 - 167                                    |
| Barley, wheat, oats <sup>3</sup><br>(Low rate - 100)  | 15                 | 125 - 188                                                  | 15 - 32                                      | 62 - 94                                                    | 7.5 - 16                                     |
|                                                       | 35                 | 292 - 438                                                  | 35 - 75                                      | 145 - 218                                                  | 18 - 37                                      |
|                                                       | 1000               | 8338 - 12507                                               | 1005 - 2135                                  | 4158 - 6237                                                | 501 - 1065                                   |
| Crop group 5A<br>Broccoli and cabbage (93333)         | 15                 | 1.9                                                        | 5.3 - 6.8                                    | 1.0                                                        | 2.6 - 3.4                                    |
|                                                       | 35                 | 4.4                                                        | 12 - 16                                      | 2.2                                                        | 6.1 - 8.0                                    |
|                                                       | 1000               | 126                                                        | 352 - 456                                    | 63                                                         | 175 - 227                                    |
| Crop group 9<br>Cucumber (pickles, 10000)             | 15                 | 2.3                                                        | 25 - 37                                      | 1.1                                                        | 12 - 19                                      |
|                                                       | 35                 | 5.3                                                        | 58 - 87                                      | 2.7                                                        | 29 - 44                                      |
|                                                       | 1000               | 152                                                        | 1664 - 2497                                  | 76                                                         | 830 - 1245                                   |
| Crop group 9<br>Summer squash (2500)                  | 15                 | 2.3                                                        | 63 - 313                                     | 1.1                                                        | 31 - 156                                     |
|                                                       | 35                 | 5.3                                                        | 146 - 731                                    | 2.7                                                        | 73 - 364                                     |
|                                                       | 1000               | 152                                                        | 4176 - 20881                                 | 76                                                         | 2083 - 10413                                 |

| Crop<br>(EEC: mg a.i./kg seed)      | Mammal<br>size (g) | Acute                                                      |                                              | Reproduction                                               |                                              |
|-------------------------------------|--------------------|------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------|----------------------------------------------|
|                                     |                    | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) | # seeds to reach<br>endpoint<br>(min to max.) <sup>1</sup> | Area required <sup>2</sup> (m <sup>2</sup> ) |
| Crop group 9<br>Pumpkin (1000)      | 15                 | 2.3                                                        | 62 – 308                                     | 1.1                                                        | 31 – 153                                     |
|                                     | 35                 | 5.3                                                        | 144 – 718                                    | 2.7                                                        | 72 – 358                                     |
|                                     | 1000               | 152                                                        | 4102 – 20509                                 | 76                                                         | 2045 – 10227                                 |
| Crop group 9<br>Citron melon (2500) | 15                 | 2.3                                                        | 111 – 209                                    | 1.1                                                        | 55 – 104                                     |
|                                     | 35                 | 5.3                                                        | 259 – 487                                    | 2.7                                                        | 129 – 243                                    |
|                                     | 1000               | 152                                                        | 7409 – 13921                                 | 76                                                         | 3695 – 6942                                  |
| Crop group 8<br>Tomato (4410)       | 15                 | 45                                                         | 36 – 868                                     | 23                                                         | 18 – 433                                     |
|                                     | 35                 | 105                                                        | 83 – 2026                                    | 53                                                         | 41 – 1010                                    |
|                                     | 1000               | 3008                                                       | 2368 – 57873                                 | 1500                                                       | 1181 – 28860                                 |
| Crop group 8<br>Peppers (12450)     | 15                 | 6.9                                                        | 69                                           | 3.4                                                        | 35                                           |
|                                     | 35                 | 16                                                         | 161                                          | 8.0                                                        | 81                                           |
|                                     | 1000               | 457                                                        | 4612                                         | 228                                                        | 2300                                         |
| Crop group 1B<br>Parsnip (2400)     | 15                 | 25                                                         | 6.8 – 12                                     | 12                                                         | 3.4 – 6.2                                    |
|                                     | 35                 | 58                                                         | 16 – 29                                      | 29                                                         | 7.9 – 15                                     |
|                                     | 1000               | 1648                                                       | 454 – 832                                    | 822                                                        | 226 – 415                                    |
| Crop group 1B<br>Carrots (20700)    | 15                 | 25                                                         | 1.9 – 8.3                                    | 12                                                         | 0.9 – 4.2                                    |
|                                     | 35                 | 58                                                         | 4.3 – 19                                     | 29                                                         | 2.2 – 9.7                                    |
|                                     | 1000               | 1648                                                       | 123 – 555                                    | 822                                                        | 61 – 277                                     |
| Crop group 3<br>Green onion (8400)  | 15                 | 19                                                         | 2.9                                          | 9.5                                                        | 1.5                                          |
|                                     | 35                 | 44                                                         | 6.8                                          | 22                                                         | 3.4                                          |
|                                     | 1000               | 1263                                                       | 195                                          | 630                                                        | 97                                           |
| Crop group 3<br>Dry onion (11200)   | 15                 | 14                                                         | 3.4 – 3.9                                    | 7.1                                                        | 1.7 – 1.9                                    |
|                                     | 35                 | 33                                                         | 8.0 – 9.0                                    | 17                                                         | 4.0 – 4.5                                    |
|                                     | 1000               | 948                                                        | 228 – 256                                    | 473                                                        | 114 – 128                                    |
| Crop group 3<br>Leeks (14000)       | 15                 | 14                                                         | 5.6 – 11                                     | 7.1                                                        | 2.8 – 5.6                                    |
|                                     | 35                 | 33                                                         | 13 – 26                                      | 17                                                         | 6.5 – 13                                     |
|                                     | 1000               | 948                                                        | 373 – 746                                    | 473                                                        | 186 – 372                                    |

<sup>1</sup> minimum to maximum number of seeds to reach endpoint based on seed size range (maximum to minimum)

<sup>2</sup> minimum and maximum area required based on minimum and maximum seeding rate

<sup>3</sup> The number of seeds to reach the endpoint and foraging distance required to achieve the endpoint is based on oats; wheat, barley and oats have been grouped together as the seed size and seeding rate range for each are very similar. The number seeds to reach the endpoints, and the required foraging distance to achieve the endpoint, are expected to be similar for each of these three seed crops.

Table 19 The number of granules required to reach the bird and mammalian endpoints

| Endpoint<br>(mg a.i./kg bw/day) | Weight (g) | Number of granules to reach endpoint |                                                    |
|---------------------------------|------------|--------------------------------------|----------------------------------------------------|
|                                 |            | PCP 25933<br>(Merit Granular)        | PCP 29185<br>(Quali-pro Imidacloprid 0.5 Granular) |
| Birds                           |            |                                      |                                                    |
| Acute - 8.07                    | 20         | 25                                   | 2                                                  |
|                                 | 100        | 127                                  | 8                                                  |
|                                 | 1000       | 1271                                 | 81                                                 |
| Reproduction – 10.0             | 20         | 31                                   | 2                                                  |
|                                 | 100        | 157                                  | 10                                                 |
|                                 | 1000       | 1575                                 | 100                                                |
| Mammals                         |            |                                      |                                                    |
| Acute – 37.9                    | 15         | 90                                   | 6                                                  |
|                                 | 35         | 209                                  | 13                                                 |
|                                 | 1000       | 5969                                 | 379                                                |
| Reproduction – 18.9             | 15         | 45                                   | 3                                                  |
|                                 | 35         | 104                                  | 7                                                  |
|                                 | 1000       | 2976                                 | 189                                                |

<sup>1</sup> # granules/day to reach endpoint = Dose-based endpoint × BW (kg bw) ÷ concentration per granule (mg a.i./granule)

Table 20 Generic bird and mammal granule consumption per day assuming granules are consumed as a food item (highly conservative)

| Species               | FIR<br>(g dw/day) | (# granules consumed/day) |           |
|-----------------------|-------------------|---------------------------|-----------|
|                       |                   | PCP 25933                 | PCP 29185 |
| Small bird - 20 g     | 5.1               | 4016                      | 255       |
| Medium bird - 100 g   | 19.9              | 15669                     | 995       |
| Large bird - 1000 g   | 58.1              | 45748                     | 2905      |
| Small mammal - 15 g   | 2.2               | 1732                      | 110       |
| Medium mammal - 35 g  | 4.5               | 3543                      | 225       |
| Large mammal - 1000 g | 68.7              | 54095                     | 3435      |

<sup>1</sup> Granules were treated as food item for this conservative assessment. The number of granules normally consumed per day was calculated as:

// granules consumed/day = IIR (g dw/day) × // of granules/g of product; for each body weight, the food ingestion rate is based on equations from Nagy, 1987 (PMRA 1918529).

**Table 21 Screening level risk quotients for birds and mammals consuming treated granules; granules treated as a food item**

| Endpoint                               | Weight (g) | PCP 25933<br>Risk quotients /<br>LOC exceeded | PCP 29185<br>Risk quotients /<br>LOC exceeded |
|----------------------------------------|------------|-----------------------------------------------|-----------------------------------------------|
| <b>Birds</b>                           |            |                                               |                                               |
| Acute<br>8.07 mg a.i./kg bw            | 20         | 161 / Yes                                     | 128 / Yes                                     |
|                                        | 100        | 123 / Yes                                     | 124 / Yes                                     |
|                                        | 1000       | 36 / Yes                                      | 36 / Yes                                      |
| Reproduction<br>10.0 mg a.i./kg bw/day | 20         | 129 / Yes                                     | 128 / Yes                                     |
|                                        | 100        | 100 / Yes                                     | 100 / Yes                                     |
|                                        | 1000       | 29 / Yes                                      | 29 / Yes                                      |
| <b>Mammals</b>                         |            |                                               |                                               |
| Acute<br>37.9 mg a.i./kg bw            | 15         | 19 / Yes                                      | 18 / Yes                                      |
|                                        | 35         | 17 / Yes                                      | 17 / Yes                                      |
|                                        | 1000       | 9 / Yes                                       | 9 / Yes                                       |
| Reproduction<br>18.9 mg a.i./kg bw/day | 15         | 39 / Yes                                      | 37 / Yes                                      |
|                                        | 35         | 34 / Yes                                      | 32 / Yes                                      |
|                                        | 1000       | 18 / Yes                                      | 18 / Yes                                      |

<sup>1</sup> Risk quotients calculated as: // of granules normally consumed per day (Appendix IX, Table 17) ÷ // of granules to the endpoint (Appendix IX, Table 16); risk quotients >1 exceed the level of concern

**Table 22 Risk quotients for mammals based on an estimate of incidental granule consumption as 1% of the EDE (PCP 25933 and 29185)**

| Endpoint                               | Weight (g) | Risk quotients /<br>LOC exceeded |
|----------------------------------------|------------|----------------------------------|
| Acute<br>37.9 mg a.i./kg bw            | 15         | 0.2 / No                         |
|                                        | 35         | 0.2 / No                         |
|                                        | 1000       | 0.1 / No                         |
| Reproduction<br>18.9 mg a.i./kg bw/day | 15         | 0.4 / No                         |
|                                        | 35         | 0.3 / No                         |
|                                        | 1000       | 0.2 / No                         |



Table 23 Effects of imidacloprid on freshwater aquatic invertebrates

| Organism        | Exposure   | Test Substance                                  | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                        | Comments                                                                                                                                                                                                                                                                                                                                                                             | Reference                                                                 |
|-----------------|------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <b>Acute</b>    |            |                                                 |                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                           |
| Midge           | Acute      | Imidacloprid (purity not reported)              | EC <sub>50</sub> = 0.069                                                                          |                                                                                                                                                                                                                                                                                                                                                                                      | EFED 2008 (PMRA 233665)                                                   |
| <i>D. magna</i> | Acute 48-h | Imidacloprid (>95% purity)                      | 48-h LC <sub>50</sub> = 10.44                                                                     | From Song <i>et al.</i> 1997 (PMRA 2541668)                                                                                                                                                                                                                                                                                                                                          | USDA 2005 (PMRA 2334762)                                                  |
|                 |            | Imidacloprid (Admire Flowable)                  | 48-h LC <sub>50</sub> = 43.3                                                                      |                                                                                                                                                                                                                                                                                                                                                                                      | Hayasaka <i>et al.</i> 2012 PMRA 2541673                                  |
|                 |            | Imidacloprid (95.9% purity)                     | 48-h LC <sub>50</sub> = 85                                                                        |                                                                                                                                                                                                                                                                                                                                                                                      | PMRA 1994 review; USDA 2005 (PMRA 2334762); (original study PMRA 1155861) |
|                 |            | Imidacloprid (97.3%)                            | 48-h LC <sub>50</sub> = 88.13                                                                     |                                                                                                                                                                                                                                                                                                                                                                                      | PMRA 1504639                                                              |
|                 |            | Imidacloprid (Confidor 200SL)                   | 48-h LC <sub>50</sub> = 96.7 (no predatory cues)<br>48-h LC <sub>50</sub> = 90.7 (predatory cues) | Acute lethality experiments were conducted in the presence of predator kairomones (brown trout) and alarm cues (macerated <i>Daphnia</i> ). EFSA 2014 aquatic risk assessment used predatory cues LC <sub>50</sub> in SSD.                                                                                                                                                           | Pestana <i>et al.</i> 2010 (PMRA 2541671)                                 |
|                 |            | Imidacloprid (Confidor, guarantee not reported) | 48-h LC <sub>50</sub> = 64.6                                                                      |                                                                                                                                                                                                                                                                                                                                                                                      | Kungolos <i>et al.</i> 2009, (PMRA 2544388)                               |
|                 |            | Imidacloprid (technical)                        | 48-h LC <sub>50</sub> = 56.6                                                                      |                                                                                                                                                                                                                                                                                                                                                                                      | Tisler <i>et al.</i> 2009 (PMRA 2541823)                                  |
|                 |            | Imidacloprid (Confidor SL200; 200 g a.i./L)     | 48-h LC <sub>50</sub> = 30.0                                                                      |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                           |
|                 |            | Imidacloprid (Confidor 200 SC)                  | 48-h EC <sub>50</sub> = 84 (immobility)                                                           | It is unclear as to whether the toxicity endpoints are based on imidacloprid measured during toxicity tests (beginning, during and end of test) or if endpoints are based on initial concentration measured in the rice fields (i.e., 8 h after application). EFSA 2014 considers the study useful as additional information but the endpoints were not used in the risk assessment. | Daam <i>et al.</i> 2013 (PMRA 2544387); EFSA 2014 (PMRA 2545413)          |

| Organism                           | Exposure   | Test Substance                                   | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                  | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reference                                                           |
|------------------------------------|------------|--------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
|                                    |            | Imidacloprid (>99.5%)                            | 48-h LC <sub>50</sub> = 64.9<br>48-h EC <sub>50</sub> = 6.0 (immobility)                    | The reviewer feels that the study authors' criteria for distinguishing between daphnia immobility and mortality are somewhat ambiguous and subjective. Immobility (lack of motion) is typically the standard measure of lethality in acute invertebrate toxicity studies (for example, 48h <i>D. magna</i> ). The immobility endpoints (EC50 value) reported in the study were chosen for SSD calculations to be consistent with other reported lethality endpoints based on immobility. | Sánchez-Bayo and Goka, 2006 (PMRA 2541831)                          |
| <i>Cypretta seuratti</i>           |            |                                                  | 48-h LC <sub>50</sub> = 0.301<br>48-h EC <sub>50</sub> = 0.016 (immobility)                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                     |
| <i>Cypridopsis vidua</i>           |            |                                                  | 48-h LC <sub>50</sub> = 0.715<br>48-h EC <sub>50</sub> = 0.003 (immobility)                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                     |
| <i>Ilyocypris dentifera</i>        |            |                                                  | 48-h LC <sub>50</sub> = 0.517<br>48-h EC <sub>50</sub> = 0.003 (immobility)                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                     |
| <i>Chydorus sphaericus</i>         |            |                                                  | 48-h LC <sub>50</sub> = 132.7<br>48-h EC <sub>50</sub> = 2.21 (immobility)                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                     |
| <i>Ceriodaphnia dubia</i>          |            | Imidacloprid (Admire Flowable)                   | 48-h LC <sub>50</sub> = 0.572                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Hayasaka <i>et al.</i> 2012 (PMRA 2541822)                          |
|                                    |            | Imidacloprid (Admire Pro)                        | 48-h LC <sub>50</sub> = 0.00207                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Chen <i>et al.</i> 2010 (PMRA 2541670)                              |
| <i>Ceriodaphnia reticulata</i>     |            | Imidacloprid                                     | 48-h LC <sub>50</sub> = 5.55                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Hayasaka <i>et al.</i> 2012 (PMRA 2541822)                          |
| <i>Daphnia pulex</i>               |            | Imidacloprid (Admire Flowable)                   | 48-h LC <sub>50</sub> = 36.9                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Hayasaka <i>et al.</i> 2012 (PMRA 2541822)                          |
| <i>Moina macrocopa</i>             | Acute 48-h | Imidacloprid (Admire Flowable)                   | 48-h LC <sub>50</sub> = 45.3                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Hayasaka <i>et al.</i> 2012 (PMRA 2541822)                          |
| Isopod<br><i>Asellus aquaticus</i> | Acute 96-h | Imidacloprid (formulated product – 200 g a.i./L) | 96-h LC <sub>50</sub> = 0.316 (mortality)<br>96-h EC <sub>50</sub> = 0.119 (immobilization) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | EFSA 2014 (PMRA 2545413) Roessink <i>et al.</i> 2013 – PMRA 2544385 |

| Organism                                            | Exposure          | Test Substance                                   | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                     | Comments | Reference                                                              |
|-----------------------------------------------------|-------------------|--------------------------------------------------|------------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------|
| Amphipod<br><i>Gammarus pulex</i>                   | Acute 96-h        |                                                  | 96-h LC <sub>50</sub> = 0.263 (mortality)<br>96-h EC <sub>50</sub> = 0.0183 (immobilization)   |          |                                                                        |
|                                                     |                   | Imidacloprid (technical)                         | 96-h LC <sub>50</sub> = 0.270                                                                  |          | EFSA 2014 (PMRA 2545413)/Beketov and Liess 2008, (PMRA 2544548)        |
|                                                     | Acute 48 and 96-h | Imidacloprid (~97%)                              | 48-h LC <sub>50</sub> = 0.11<br>96-h LC <sub>50</sub> = 0.13                                   |          | Ashauer <i>et al.</i> 2011 (PMRA 2541673)                              |
| Amphipod<br><i>Gammarus roeseli</i>                 | Acute 96-h        | Imidacloprid (purity not reported)               | 96-h EC <sub>50</sub> = 0.0142 (immobilization)                                                |          | Böttger <i>et al.</i> 2012 (PMRA 2541837);<br>EFSA 2014 (PMRA 2545413) |
| Mayfly larvae <i>Baetis rhodani</i>                 | Acute 48-h        | Imidacloprid (technical)                         | 48-h LC <sub>50</sub> = 0.00849                                                                |          | EFSA 2014 (PMRA 2545413)/Beketov and Liess 2008, (PMRA 2544548)        |
| Blackfly larvae<br><i>Simulium latigonium</i>       | Acute 96-h        | Imidacloprid (technical)                         | 96-h LC <sub>50</sub> = 0.00373                                                                |          |                                                                        |
| Midge larvae<br><i>Chaoborus obscuripes</i>         | Acute 96-h        | Imidacloprid (formulated product – 200 g a.i./L) | 96-h LC <sub>50</sub> = 0.294 (mortality)<br>96-h EC <sub>50</sub> = 0.284 (immobilization)    |          | EFSA 2014 (PMRA 2545413)/Roessink <i>et al.</i> 2013 (PMRA 2544385)    |
| Alderfly larvae<br><i>Sialis lutaria</i>            | Acute 96-h        |                                                  | 96-h LC <sub>50</sub> > 10 (mortality)<br>96-h EC <sub>50</sub> = 0.0506 (immobilization)      |          |                                                                        |
| Pygmy backswimmer larvae<br><i>Plea minutissima</i> | Acute 96-h        |                                                  | 96-h LC <sub>50</sub> = 0.0375 (mortality)<br>96-h EC <sub>50</sub> = 0.0359 (immobilization)  |          |                                                                        |
| Backswimmer<br><i>Notonecta</i> spp.                | Acute 96-h        |                                                  | 96-h LC <sub>50</sub> > 10 (mortality)<br>96-h EC <sub>50</sub> = 0.0182 (immobilization)      |          |                                                                        |
| Water boatman<br><i>Micronecta</i> spp.             | Acute 96-h        |                                                  | 96-h LC <sub>50</sub> = 0.0282 (mortality)<br>96-h EC <sub>50</sub> = 0.0108 (immobilization)  |          |                                                                        |
| Caddisfly larvae<br>Limnephilidae                   | Acute 96-h        |                                                  | 96-h LC <sub>50</sub> = 0.0257 (mortality)<br>96-h EC <sub>50</sub> = 0.00179 (immobilization) |          |                                                                        |

| Organism                                            | Exposure         | Test Substance                                  | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                              | Comments                                                                                                                                                                                                                                                                                                                                                                             | Reference                                                                   |
|-----------------------------------------------------|------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Mayfly larvae<br><i>Caenis horaria</i>              | Acute 96-h       |                                                 | 96-h LC <sub>50</sub> = 0.00668 (mortality)<br>96-h EC <sub>50</sub> = 0.00177 (immobilization)         |                                                                                                                                                                                                                                                                                                                                                                                      | EFSA 2014 (PMRA 2545413); RPA van Wijngaarden and I Roessink. January 2013. |
|                                                     |                  |                                                 | 72-h EC <sub>50</sub> = 0.017 (immobilization)                                                          |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |
| Mayfly larvae<br><i>Cloeon dipterum</i>             | Acute 96-h       |                                                 | 96-h LC <sub>50</sub> = 0.0263(mortality)<br>96-h EC <sub>50</sub> = 0.00102 (immobilization)           |                                                                                                                                                                                                                                                                                                                                                                                      | EFSA 2014 (PMRA 2545413)/Roessink <i>et al.</i> 2013 – PMRA 2544385         |
|                                                     |                  |                                                 | 96-h EC <sub>50</sub> = 0.012 (immobilization)                                                          |                                                                                                                                                                                                                                                                                                                                                                                      | EFSA 2014 (PMRA 2545413); van Wijngaarden and Roessink. January 2013.       |
| Damselfly<br>Cocnagrionidae<br>(Zygoptera)          | Acute 96-h       | 96-h EC <sub>50</sub> = 150 (immobilization)    |                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |
| Amphipod<br><i>Gammarus fossarum</i>                | Acute 24-h       | Imidacloprid<br>(Confidor 200SL, –200 g a.i./L) | 24-h NOEC = 0.205 (mortality)                                                                           | Mortality was significant at the two highest test concentrations – 40 and 46% at 0.256 and 0.511 mg a.i./L.                                                                                                                                                                                                                                                                          | Malev <i>et al.</i> 2012, (PMRA 2541840)                                    |
| Mosquito larvae<br><i>Aedes aegypti</i>             | Acute 48-h       | Imidacloprid<br>(~95% purity)                   | 48-h LC <sub>50</sub> = 0.044                                                                           | From Song <i>et al.</i> 1997 (PMRA 2541668)                                                                                                                                                                                                                                                                                                                                          | USDA 2005 (PMRA 2334762)                                                    |
| Ostracod<br><i>Heterocypris incongruens</i>         | Acute 6-d        | Imidacloprid<br>(Confidor 200 SC)               | 6-d EC <sub>50</sub> = 0.01 – 0.015 (growth inhibition)<br><br>6-d LC <sub>50</sub> > 0.015 (mortality) | It is unclear as to whether the toxicity endpoints are based on imidacloprid measured during toxicity tests (beginning, during and end of test) or if endpoints are based on initial concentration measured in the rice fields (i.e., 8 h after application). EFSA 2014 considers the study useful as additional information but the endpoints were not used in the risk assessment. | Daam <i>et al.</i> 2013 (PMRA 2544387); EFSA 2014 (PMRA 2545413)            |
| Mayfly larvae<br><i>Epeorus longinatus</i><br>Eaton | Acute 24-h       | Imidacloprid<br>(Admire, 240 g a.i./L.)         | 24-h LC <sub>50</sub> = 0.0021                                                                          |                                                                                                                                                                                                                                                                                                                                                                                      | Alexander <i>et al.</i> 2007 (PMRA 2541832); EFSA 2014 (PMRA 2545413)       |
|                                                     | Acute 96-h       |                                                 | 96-h LC <sub>50</sub> = 0.00065                                                                         |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                             |
|                                                     | Acute 24-h pulse |                                                 | NOEC = 0.0001 (reduced feeding rate)                                                                    | The experiment consisted of a 24-h pulse exposure followed by a 4 day post-exposure period. The NOEC is based on reduced feeding rate measured at the end of the post-exposure period (day 5).                                                                                                                                                                                       |                                                                             |



| Organism                                     | Exposure   | Test Substance                            | Endpoint Value <sup>a</sup><br>(mg a.i./L)             | Comments                                                                                                                                                     | Reference                                                                                   |
|----------------------------------------------|------------|-------------------------------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Black fly larvae<br><i>Simulium vittatum</i> | Acute 48-h | Imidacloprid<br>(~98% purity)             | 48-h LC <sub>50</sub> = 0.00818                        | This endpoint value is the mean of three LC50 values reported from three separate tests; EFSA 2014 used the lowest LC50 of the three tests (6.75 µg a.i./L.) | Overmeyer <i>et al.</i> 2005; EFSA 2014 (PMRA 2545413)                                      |
| Amphipod<br><i>Hyalella azteca</i>           | Acute 96-h | Imidacloprid (purity not reported)        | 96-h LC <sub>50</sub> = 0.526                          |                                                                                                                                                              | PMRA 1994 review; USDA 2005 (PMRA 2334762); (original study PMRA 1155859)                   |
|                                              | Acute 96-h | Imidacloprid-guanidine (NTN 33823, 96.9%) | 96-h LC <sub>50</sub> = 51.8                           |                                                                                                                                                              | USDA 2005 (PMRA 2334762); (original study PMRA 1167316 - 1166100)                           |
|                                              | Acute 96-h | Imidacloprid-urea (NTN 33519)             | 96-h LC <sub>50</sub> > 94.83                          |                                                                                                                                                              | USDA 2005 (PMRA 2334762); (original study PMRA 1166103)                                     |
|                                              | Acute 96-h | Imidacloprid technical                    | 96-h LC <sub>50</sub> = 0.065                          |                                                                                                                                                              | Stoughton <i>et al.</i> 2008 (PMRA 2541839); EFSA 2014 (PMRA 2545413)                       |
|                                              | Acute 96-h | Admire (240 g a.i./L.)                    | 96-h LC <sub>50</sub> = 0.0174                         |                                                                                                                                                              |                                                                                             |
| Midge larvae<br><i>Chironomus tentans</i>    | Acute 96-h | Imidacloprid (95% purity)                 | 96-h LC <sub>50</sub> = 0.0105<br>96-h NOEC = 0.00124  |                                                                                                                                                              | USDA 2005 (PMRA 2334762); (original study PMRA 1155863)                                     |
|                                              | Acute 96-h | Imidacloprid (Admire 240F)                | 96-h LC <sub>50</sub> = 0.00265<br>96-h NOEC = 0.00139 |                                                                                                                                                              | Leblanc <i>et al.</i> 2012, (PMRA 2544384)                                                  |
|                                              | Acute 96-h | Imidacloprid-guanidine (NTN 33823, 96.9%) | 96-h LC <sub>50</sub> > 82.8                           |                                                                                                                                                              | USDA 2005 (PMRA 2334762); EFSA 2014 (PMRA 2545413); (original study PMRA 1167315 - 1166101) |
|                                              | Acute 96-h | Imidacloprid-urea (NTN 33519)             | 96-h LC <sub>50</sub> > 99.80                          |                                                                                                                                                              | USDA 2005 (PMRA 2334762); EFSA 2014 (PMRA 2545413)                                          |
|                                              | Acute 96-h | 6-chloronicotinic acid (97% a.i.)         | 96-h LC <sub>50</sub> > 1                              |                                                                                                                                                              | USDA 2005 (PMRA 2334762); EFSA 2014 (PMRA 2545413); (original study PMRA 1182985 - 1181128) |
|                                              | Acute 96-h | Imidacloprid technical                    | 96-h LC <sub>50</sub> = 0.00575                        |                                                                                                                                                              | Stoughton <i>et al.</i> 2008 (2541839); EFSA 2014 (PMRA 2545413)                            |

| Organism                                        | Exposure           | Test Substance                                 | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                          | Comments                                                                                                                                                                                                                      | Reference                                                                    |
|-------------------------------------------------|--------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
|                                                 | Acute 96-h         | Admire (240 g a.i./L)                          | 96-h LC <sub>50</sub> = 0.00540                                                                     |                                                                                                                                                                                                                               |                                                                              |
| Midge larvae<br><i>Chironomus riparius</i>      | Acute<br>24 - 48-h | Imidacloprid<br>(Confidor 200SL)               | 48-h LC <sub>50</sub> = 0.0199                                                                      |                                                                                                                                                                                                                               | Azevedo-Pereira <i>et al.</i> 2011a, (PMRA 2541835)                          |
|                                                 |                    | Imidacloprid-5-hydroxy                         | 24-h LC <sub>50</sub> = 0.668                                                                       |                                                                                                                                                                                                                               | EFSA 2008 (PMRA 2332663)                                                     |
|                                                 |                    | Imidacloprid-nitroso                           | 24-h LC <sub>50</sub> = 0.283                                                                       |                                                                                                                                                                                                                               |                                                                              |
|                                                 | Acute 48 - 96-h    | Imidacloprid<br>(Confidor 200SL)               | 96-h NOEC = 0.00055 (reduced locomotion)                                                            | The experiments consisted of exposure followed by a 48 hour recovery period. Reduced ventilation and AChE activity were observed at all test concentrations (i.e., NOEC below the lowest test concentration of 0.00055 mg/L). | Azevedo-Pereira <i>et al.</i> 2011b (PMRA 2544386); EFSA 2014 (PMRA 2545413) |
|                                                 | Acute 96-h         | Imidacloprid (Confidor 200SL; 200 g a.i./L)    | 96-h LC <sub>50</sub> = 0.013 (no predatory cues)<br>96-h LC <sub>50</sub> = 0.014 (predatory cues) | Acute lethality experiments were conducted in the presence and absence of predator kairomones (brown trout) and alarm cues (macerated <i>C. riparius</i> or <i>S. vittatum</i> , depending on the test).                      | Pestana <i>et al.</i> 2009b (PMRA 2544390)                                   |
| Caddisfly larvae<br><i>Seristocoma vittatum</i> |                    |                                                | 96-h LC <sub>50</sub> = 0.047 (no predatory cues)<br>96-h LC <sub>50</sub> = 0.036 (predatory cues) |                                                                                                                                                                                                                               |                                                                              |
| Oligochaete<br><i>Lumbriculus variegatus</i>    | Acute 96-h         | Imidacloprid<br>(Admire, 240 g a.i./L)         | 96-h LC <sub>50</sub> = 0.0062                                                                      |                                                                                                                                                                                                                               | Alexander <i>et al.</i> 2007 (PMRA 2541832); EFSA 2014 (PMRA 2545413)        |
|                                                 | Acute 24-h pulse   |                                                | NOEC = 0.001 (reduced egestion rate)                                                                | The experiment consisted of a 24-h pulse exposure followed by a 4 day post-exposure period. The NOEC is based on reduced egestion rate measured at the end of the post-exposure period (day 5).                               |                                                                              |
| Stonefly larvae<br><i>Pteronarcys dorsata</i>   | Acute 14-d         | Imidacloprid<br>(Confidor 200SL; 200 g a.i./L) | 14-d LC <sub>50</sub> = 0.070                                                                       | Results are for microcosm experiments containing both species; imidacloprid was applied directly to microcosms. By the end of the 14-day experimental                                                                         | Kreutzweiser <i>et al.</i> 2008 (PMRA 2544383)                               |

| Organism                                    | Exposure                    | Test Substance                                | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                                               | Comments                                                                                                                                                                                                                                                                                                                                             | Reference                                                           |
|---------------------------------------------|-----------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Crane fly<br><i>Tipula sp.</i>              |                             |                                               | 14-d LC <sub>50</sub> = 0.139                                                                                            | period, concentrations in water were reduced by 53%–55%.                                                                                                                                                                                                                                                                                             |                                                                     |
| Chronic                                     |                             |                                               |                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                      |                                                                     |
| <i>D. magna</i>                             | 21 d Chronic Static renewal | Imidacloprid (purity not reported)            | EC50 > 7.3 (immobilization)<br>21 d NOEC = 1.8<br>21 d LOEC = 3.6                                                        | LOEC: Significantly reduced adult daphnid length in comparison with pooled controls.                                                                                                                                                                                                                                                                 | EFED 2008 (PMRA 2332665); (original study PMRA 1155875)             |
|                                             | 21 d Chronic Static renewal | Imidacloprid (purity not reported)            | 21 d NOEC = 2.0 (cumulative offspring/live daphnia)<br>21 d EC <sub>50</sub> = 5.5                                       | Based on reduced cumulative number of offspring/live daphnia after exposure. Adult body length was also significantly affected at ≥ 6 mg a.i./L (NOEC = 4.0 mg a.i./L.)                                                                                                                                                                              | Pavlaki <i>et al.</i> 2011 (PMRA 2541825)                           |
|                                             | 21 d Chronic Static renewal | Imidacloprid technical                        | 21 d NOEC = 1.25 (no. neonates/adult)<br>21 d NOEC = 20 (mortality)                                                      |                                                                                                                                                                                                                                                                                                                                                      | Jemec <i>et al.</i> 2007 (PMRA 2541824)                             |
|                                             |                             | Imidacloprid (Confidor 200 SL.)               | 21 d NOEC = 2.5 (no. neonates/adult, brood size and days to first brood)<br>21 d NOEC = 5.0 (mortality)                  |                                                                                                                                                                                                                                                                                                                                                      |                                                                     |
|                                             | 21 d Chronic Static renewal | Imidacloprid (97.7%)                          | 21 d NOEC = 2.0 (reproduction, growth rate of parent)<br>21 d NOEC = 2.0 (mortality; based on visual inspection of data) | The effect of imidacloprid at a range of nutritional levels (defined as algae C:P ratios) on <i>D. magna</i> was investigated; juveniles were supplied with 4 different food quality levels and exposed to a range of imidacloprid concentrations for 21 days under semi-static conditions. Survival, growth rates, and reproduction were monitored. | Ieromina <i>et al.</i> 2014, (PMRA 2541828)                         |
|                                             | 34 d Chronic                | Imidacloprid (99%)                            | NOEC = 1.3<br>(reproduction: reduced number offspring/brood)                                                             | Exposure phase was 7 days after which organisms transferred to clean media. Test conditions reported as quasi-static – i.e., exposure media was changed once during the seven day exposure phase.                                                                                                                                                    | Agatz <i>et al.</i> 2013 (PMRA 2541826)                             |
| Isopod<br><i>Asellus aquaticus</i>          | 28 d Chronic                | Imidacloprid (Confidor 200SL – 200 g a.i./L.) | 28 d LC <sub>50</sub> = 0.0203<br>28 d EC <sub>50</sub> = <b>0.012</b>                                                   | EFSA used 28 day EC <sub>50</sub> (immobilization) for SSD calculations.                                                                                                                                                                                                                                                                             | EFSA 2014 (PMRA 2545413)/Roessink <i>et al.</i> 2013 – PMRA 2544385 |
| Amphipod<br><i>Gammarus pulex</i>           |                             |                                               | 28 d LC <sub>50</sub> = 0.0338<br>28 d EC <sub>50</sub> = <b>0.015</b>                                                   |                                                                                                                                                                                                                                                                                                                                                      |                                                                     |
| Midge larvae<br><i>Chaoborus obscuripes</i> |                             |                                               | 28 d LC <sub>50</sub> = 0.0126<br>28 d EC <sub>50</sub> = <b>0.012</b>                                                   |                                                                                                                                                                                                                                                                                                                                                      |                                                                     |
|                                             |                             |                                               |                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                      |                                                                     |

| Organism                                            | Exposure                     | Test Substance                      | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                                                                                                                                                                                   | Comments                                                                                                                                                                                                                                     | Reference                                                                                      |
|-----------------------------------------------------|------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Alderfly larvae<br><i>Sialis lutaria</i>            |                              |                                     | 28 d LC <sub>50</sub> = 0.0325                                                                                                                                                                                                                               |                                                                                                                                                                                                                                              |                                                                                                |
|                                                     |                              |                                     | 28 d EC <sub>50</sub> = <b>0.0035</b>                                                                                                                                                                                                                        |                                                                                                                                                                                                                                              |                                                                                                |
| Pygmy backswimmer larvae<br><i>Plea minutissima</i> |                              |                                     | 28 d LC <sub>50</sub> = 0.0098                                                                                                                                                                                                                               |                                                                                                                                                                                                                                              |                                                                                                |
|                                                     |                              |                                     | 28 d EC <sub>50</sub> = <b>0.0065</b>                                                                                                                                                                                                                        |                                                                                                                                                                                                                                              |                                                                                                |
| Mayfly larvae<br><i>Caenis horaria</i>              |                              |                                     | 28 d LC <sub>50</sub> = 0.000316                                                                                                                                                                                                                             |                                                                                                                                                                                                                                              |                                                                                                |
|                                                     |                              |                                     | 28 d EC <sub>50</sub> = <b>0.00013</b>                                                                                                                                                                                                                       |                                                                                                                                                                                                                                              |                                                                                                |
| Mayfly larvae<br><i>Cloeon dipterum</i>             |                              |                                     | 28 d LC <sub>50</sub> = 0.000195                                                                                                                                                                                                                             |                                                                                                                                                                                                                                              |                                                                                                |
|                                                     |                              |                                     | 28 d EC <sub>50</sub> = <b>0.00012</b>                                                                                                                                                                                                                       |                                                                                                                                                                                                                                              |                                                                                                |
| Midge larvae<br><i>Chironomus tentans</i>           | 10 d Chronic, static renewal | Imidacloprid (95% a.i.)             | 10 d LC <sub>50</sub> = 0.00317 10 d NOEC = 0.00124 (survival)<br>10 d NOEC = 0.00067 (growth)                                                                                                                                                               |                                                                                                                                                                                                                                              | PMRA 1994 review (PMRA 2308699);<br>USDA 2005 (PMRA 2334762);<br>(original study PMRA 1155863) |
|                                                     | 28 d Chronic, static renewal | Imidacloprid (Admire; 240 g a.i./L) | <u>Constant exposure</u><br>28 d LC <sub>50</sub> = <b>0.00091</b> (survival; equivalent to 28 d EC <sub>50</sub> for emergence)*<br>28 d NOEC = 0.00114 (survival, dry weight)<br><br><u>Pulse exposure**</u><br>28 d NOEC = 0.00347 (survival, dry weight) | *LC <sub>50</sub> is equivalent to EC <sub>50</sub> (emergence) because survival was measured as emerged adults<br><br>**Pulse exposure experiments consisted of 4 days of exposure followed by 24 days in clean substrate and culture media | Stoughton <i>et al.</i> 2008 (PMRA 2541839); EFSA 2014 (PMRA 2545413)                          |
| Amphipod<br><i>Hyallela azteca</i>                  | 28 d Chronic, static renewal | Imidacloprid (Admire; 240 g a.i./L) | <u>Constant exposure</u><br>28 d LC <sub>50</sub> = <b>0.00708</b> (survival)<br>28 d NOEC = 0.00344 (survival)<br>28 d NOEC = 0.0115 (dry weight)<br><br><u>Pulse exposure*</u><br>28 d NOEC = 0.00353 (survival)<br>28 d NOEC = 0.0119 (dry weight)        |                                                                                                                                                                                                                                              |                                                                                                |



| Organism                                      | Exposure     | Test Substance                                             | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                               | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reference                                           |
|-----------------------------------------------|--------------|------------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| Midge larvae<br><i>Chironomus riparius</i>    | 28 d Chronic | Imidacloprid<br>(Confidor 200SL)                           | EC <sub>50</sub> = 0.0036<br>NOEC = 0.0027<br>(emergence)                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | EFSA 2008 (PMRA 2332663)                            |
|                                               |              | Imidacloprid (purity not reported)                         | EC <sub>50</sub> = 0.00311<br>(emergence)                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                     |
|                                               | 10 d chronic | Imidacloprid<br>(Confidor 200SL; 200g a.i./L)              | 10d-NOEC = 0.00074<br>(decreased growth, reduced locomotion and ventilation frequencies) | Note: The study also included a 4 day pulse exposure followed by a 6 day recovery period; growth relative to control group recovered 6 days following exposure at the highest test concentration. Behavioural observations (reduced locomotion and ventilation frequencies), however, did not fully recover after the 6 day recovery period.                                                                                                                                                                                              | Azevedo-Pereira <i>et al.</i> 2011a, (PMRA 2541835) |
|                                               |              |                                                            | 10d-NOEC = 0.0004<br>(decreased growth, emergence)                                       | Note: A NOEC for developmental rate could not be determined (i.e., NOEC below the lowest test concentration).                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                     |
|                                               | 28 d Chronic | Imidacloprid-desnitro                                      | EC <sub>50</sub> = 46<br>(emergence)                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | EFSA 2008 (PMRA 2332663)                            |
|                                               |              | Imidacloprid-urea                                          | EC <sub>50</sub> = 249<br>(emergence)                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                     |
|                                               |              | Imidacloprid-AMCP<br>(1-(6-chloropyridin-3-yl)methanamine) | EC <sub>50</sub> > 105<br>(emergence)                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                     |
|                                               |              | Imidacloprid-desnitro-olefin                               | EC <sub>50</sub> = 21.3<br>(emergence)                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                     |
| Stonefly larvae<br><i>Pteronarcys dorsata</i> | 14 d chronic | Imidacloprid<br>(Ecoprid, 50 mg/mL formulated product)     | 14-d NOEC = 0.012 (mortality)                                                            | Results are for laboratory microcosm experiments containing both species; imidacloprid was applied directly to microcosms. Based on concurrently run fate microcosms, (i.e., no organisms present), imidacloprid concentration in water declined over time across all treatments. Day 14 measured imidacloprid concentrations were 42 – 61% of nominal concentrations for the 0.012 to 15.4 mg a.i./L microcosms. The 14 day NOEC (based on nominal concentrations on Day 14), therefore, likely represents an underestimate of toxicity. | Kreutzweiser <i>et al.</i> 2007 (PMRA 2541841)      |
| Crane fly<br><i>Tipula</i> sp.                |              |                                                            |                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                     |

<sup>a</sup> Endpoints in bold were used to determine HC<sub>5</sub> value (the 5<sup>th</sup> percentile of the species sensitivity distribution for the EC<sub>50</sub>/LC<sub>50</sub> at 50% confidence intervals); geomean values were used for species with multiple endpoint values. Chronic HC<sub>5</sub> = 0.041 µg a.i./L.

**Table 24 Effects of imidacloprid on fish**

| Organism                                           | Exposure                                     | Test Substance                     | Endpoint Value<br>(mg a.i./L)                                                                     | Comments                                                                                                                                                                                                                                                  | Reference                                                                         |
|----------------------------------------------------|----------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Freshwater fish - Acute                            |                                              |                                    |                                                                                                   |                                                                                                                                                                                                                                                           |                                                                                   |
| Bluegill sunfish<br>( <i>Lepomis macrochirus</i> ) | Acute, 96-h<br>(flow-through)                | Imidacloprid (97.4%)               | 96-h LC <sub>50</sub> > 105<br>(greater than the limit of solubility)<br>NOAEC = 25 mg/L          | 42 mg/L and higher: mortality, dark discoloration, fish on the bottom of test chamber, erratic swimming, surfacing, quiescence, rapid fin movement, labored respiration. A surface film and precipitate on the bottom were noted at these concentrations. | EFED 2008; USDA 2005 (PMRA 2334762); (original study PMRA 1155854)                |
| Rainbow trout<br>( <i>Oncorhynchus mykiss</i> )    | Acute, 96-h<br>(static)                      | Imidacloprid (95.3%)               | 96-h LC <sub>50</sub> = 211<br>NOEC = 50                                                          | 89 mg/L and higher: apathy, irregular swimming behavior, lying on side/back, staggering<br>281 mg/L and higher: mortality                                                                                                                                 | EFSA 2008 (PMRA 2332663); USDA 2005 (PMRA 2334762); (original study PMRA 1155850) |
|                                                    | Acute, 96-h<br>(semi-static)                 | Imidacloprid (97.4%)               | 96-h LC <sub>50</sub> > 83<br>NOEC = 42                                                           | 64 mg/L and higher: mortality, dark discoloration, fish on the bottom of test chamber, erratic swimming, quiescence. A surface film and precipitate on the bottom were noted at concentrations at and above 42 mg/L.                                      | EFSA 2008 (PMRA 2332663); USDA 2005 (PMRA 2334762); (original study PMRA 1155851) |
| Guppy <i>Poecilia reticulata</i>                   | Acute, 96-h<br>(semi-static)                 | Imidacloprid (97.3%)               | 96-h LC <sub>50</sub> > 100 (limit test)                                                          |                                                                                                                                                                                                                                                           | PMRA 1504640                                                                      |
| Zebrafish<br><i>Danio rerio</i>                    | Acute, 96-h                                  | Imidacloprid (purity not reported) | 96-h LC <sub>50</sub> = 281                                                                       |                                                                                                                                                                                                                                                           | Ding et al. 2004 (PMRA 2544543)                                                   |
|                                                    | Acute, 96-h<br>(static)                      | Imidacloprid technical             | 96-h LC <sub>50</sub> = 241                                                                       | Adult zebrafish                                                                                                                                                                                                                                           | Tisler et al. 2009 (PMRA 2541823)                                                 |
|                                                    |                                              | Confidor 200 SL                    | 96-h LC <sub>50</sub> = 214                                                                       |                                                                                                                                                                                                                                                           |                                                                                   |
|                                                    | Acute, 48 h<br>(static)                      | Imidacloprid technical             | 48-h LC <sub>50</sub> > 320                                                                       | Zebrafish embryos                                                                                                                                                                                                                                         |                                                                                   |
|                                                    |                                              | Confidor 200 SL                    | 48-h LC <sub>50</sub> = 502                                                                       |                                                                                                                                                                                                                                                           |                                                                                   |
|                                                    | Acute, 96-h<br>(static-renewal)              | Imidacloprid technical             | 95-h NOEC ≥ 50                                                                                    | Zebrafish embryos                                                                                                                                                                                                                                         | Scheil and Köhler, 2009 (PMRA 2544542)                                            |
| Acute, 96-h<br>(static)                            | Imidacloprid<br>(35% suspension concentrate) | 96-h LC <sub>50</sub> > 100        | English Abstract available only; journal article written in Chinese. Cited in EFSA 2014; followed | Chen et al. 2013 (PMRA 2535327); EFSA 2014 (PMRA 2545413)                                                                                                                                                                                                 |                                                                                   |

| Organism                                          | Exposure                           | Test Substance                                 | Endpoint Value<br>(mg a.i./L)                                                        | Comments                                                                                                                                                                                                                                                | Reference                                               |
|---------------------------------------------------|------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
|                                                   |                                    | Imidacloprid<br>(70% wet seed dressing agent)  | 96-h LC <sub>50</sub> = 17.8                                                         | guideline 203.                                                                                                                                                                                                                                          |                                                         |
|                                                   |                                    | Imidacloprid<br>(70% wettable powder)          | 96-h LC <sub>50</sub> = 45.2                                                         |                                                                                                                                                                                                                                                         |                                                         |
|                                                   |                                    | Imidacloprid<br>(600 g/L flowable concentrate) | 96-h LC <sub>50</sub> >100                                                           |                                                                                                                                                                                                                                                         |                                                         |
| Freshwater Fish - Chronic                         |                                    |                                                |                                                                                      |                                                                                                                                                                                                                                                         |                                                         |
| Rainbow trout<br><i>Oncorhynchus mykiss</i>       | ELS 91-d, flow-through             | Imidacloprid technical                         | NOEC = 9.02                                                                          | Nature of endpoint not reported.                                                                                                                                                                                                                        | EFSA 2008 (PMRA 2332663)                                |
|                                                   | ELS 98-d, flow-through             | Imidacloprid technical                         | NOEC = 9.8<br>LOEC = 19                                                              | Statistically significant reduction in length at 36 and 60 days post-hatch, and body weight at 60 days posthatch). No statistically significant biologically important effects on egg viability, hatch, survival or behavioral variables were observed. | USDA 2005 (PMRA 2334762); (original study PMRA 1155855) |
|                                                   | ELS 98-d                           | Imidacloprid                                   | NOEC = 1.2<br>LOEC = 2.5                                                             | Reproduction and growth                                                                                                                                                                                                                                 | EFED 2008; (original study PMRA 1155857)                |
| Fathead minnow<br><i>Pimephales promelas</i>      | 21-d short-term reproduction assay | Imidacloprid (99.4%)                           | NOEC = 9.02                                                                          | No increased mortality or effects on reproduction or to other parameters measured reflective of reproductive endocrine disruption (GSI, gonadal histology, plasma vitellogenin).                                                                        | PMRA 2192429                                            |
| Marine fish - Acute                               |                                    |                                                |                                                                                      |                                                                                                                                                                                                                                                         |                                                         |
| Sheepshead minnow<br><i>Cyprinodon variegatus</i> | 96-h<br>Flow-through               | Imidacloprid (96.2%)                           | 96-h LC <sub>50</sub> = 161<br>NOEC = 58.2 (mortality, lethargy and dark coloration) |                                                                                                                                                                                                                                                         | PMRA 2334762 and 2332663                                |

Table 25 Effects of imidacloprid on amphibians

| Organism                                                                                                                                          | Exposure                                                                                                                 | Test Substance          | Endpoint Value<br>(mg a.i./L)                                                                                                                          | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Reference                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <b>Amphibians</b>                                                                                                                                 |                                                                                                                          |                         |                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                     |
| Paddy field frog<br><i>Rana limnocharis</i><br>tadpoles                                                                                           | Acute, 96 h                                                                                                              | Imidacloprid (>95%)     | LC <sub>50</sub> = 82<br>NOEC = 16.7; LOEC = 30                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | USDA 2005 (PMRA 2334762);<br>Feng <i>et al.</i> 2004 (PMRA 2544547) |
| Dark-spotted pond<br>frog<br><i>Rana</i><br><i>Nigromaculata</i><br><i>hallowell</i><br>tadpoles                                                  | Acute, 96 h                                                                                                              | Imidacloprid (>95%)     | LC <sub>50</sub> = 129<br>NOEC = 67.5; LOEC = 101.2                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | USDA 2005 (PMRA 2334762);<br>Feng <i>et al.</i> 2004 (PMRA 2544547) |
| <i>Rana berlandieri</i><br><i>Pseudacris</i><br><i>triseriata</i><br><i>Bufo americanus</i>                                                       | Acute                                                                                                                    | Imidacloprid (75% a.i.) | LC <sub>50</sub> = 185 ( <i>R. berlandieri</i> )<br>LC <sub>50</sub> = 389 ( <i>P. triseriata</i> )<br>LC <sub>50</sub> = 468 ( <i>B. Americanus</i> ) | The tadpole larval stage used for the lethal tests and exposure duration is not reported. These data will, therefore, not be considered.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Howard and Julian 2003; (PMRA 2574062)                              |
| <i>Rana pipiens</i> ,<br><i>Pseudacris</i><br><i>triseriata</i> ,<br><i>Ambystoma</i><br><i>jeffersonianum</i> , <i>Bufo</i><br><i>americanus</i> | Hatching success and development                                                                                         | Imidacloprid (75% a.i.) | Hatching success: NOEC ≥ 110 mg/L<br>Deformities: NOEC = 88 (for all species except <i>P. triseriata</i> )<br>NOEC = 17.5 ( <i>P. triseriata</i> )     | Details of study were obtained from the 2005 USDA review of imidacloprid. The duration of the exposure was not reported. <i>P. triseriata</i> had a high percentage of total deformities which approached but did not achieve a statistically significant difference from control values at the highest concentration tested (88-100 mg/L). The USDA states that it is possible that the high variability in the control percentage for <i>pseudacris</i> prevented statistical significance, and that the next lowest concentration (17.5-20 mg/L) is actually the NOAEC; the USDA selected 17.5 mg/L as the chronic NOAEC for evaluating sensitive amphibian species. | USDA 2005 (PMRA 2334762)                                            |
| African clawed-frog<br><i>Xenopus laevis</i>                                                                                                      | 21 day metamorphosis assay: 0, 0.72, 3.7 and 18.0 mg a.i./L nominal; <0.072, 0.73, 3.7 and 18.5 mg a.i./L mean measured. | Imidacloprid (99.4%)    | NOEC = 3.7                                                                                                                                             | Based on significantly lower normalized hind limb length at 18.5 mg a.i./L.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PMRA 2192430                                                        |



Table 26 Effects of imidacloprid on freshwater algae and vascular plants

| Organism                                              | Exposure                  | Test Substance                                   | Endpoint Value<br>(mg a.i./L)                    | Comments                                                                                                                                                                                                                                                                                                                                                                             | Reference                                                                                    |
|-------------------------------------------------------|---------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| <b>Algae</b>                                          |                           |                                                  |                                                  |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                              |
| Green algae<br><i>Pseudokirchneriella subcapitata</i> | Acute, 120 h static       | Imidacloprid (95%)                               | EC <sub>50</sub> > 119                           | Biomass and growth                                                                                                                                                                                                                                                                                                                                                                   | USDA 2005 (PMRA 2334762); EFSA 2008 (PMRA 2332663); (original study PMRA 1157927)            |
|                                                       | Acute, 72 h static        | Imidacloprid (Confidor, guarantee not reported)  | IC <sub>50</sub> > 1000                          | Growth                                                                                                                                                                                                                                                                                                                                                                               | Kungolos <i>et al.</i> 2009, (PMRA 2544388)                                                  |
|                                                       | Acute, 72 h static        | Imidacloprid (Confidor 200 SC)                   | EC <sub>50</sub> > 600 (growth)                  | It is unclear as to whether the toxicity endpoints are based on imidacloprid measured during toxicity tests (beginning, during and end of test) or if endpoints are based on initial concentration measured in the rice fields (i.e., 8 h after application). EFSA 2014 considers the study useful as additional information but the endpoints were not used in the risk assessment. | Daam <i>et al.</i> 2013 (PMRA 2544387); EFSA 2014 (PMRA 2545413)                             |
| Green algae<br><i>Scenedesmus subspicatus</i>         | Acute, 96 h static        | Imidacloprid (92.8%)                             | EC <sub>50</sub> > 10                            | Biomass and growth                                                                                                                                                                                                                                                                                                                                                                   | USDA 2005 (PMRA 2334762); EFED 2008; EFSA 2008 (PMRA 2332663); (original study PMRA 1157928) |
| Green algae<br><i>Desmodesmus subspicatus</i>         | Acute, 72h static         | Imidacloprid technical Confidor SL200            | EC <sub>50</sub> = 389<br>EC <sub>50</sub> = 116 | Growth                                                                                                                                                                                                                                                                                                                                                                               | Tisler <i>et al.</i> 2009 (PMRA 2541823)                                                     |
| Blue-green algae<br><i>Anabaena flos-aquae</i>        | Acute, 96 h static        | Imidacloprid (formulated product 2F, 21.6% a.i.) | EC <sub>50</sub> = 32.8<br>NOEC = 24.9           | Cell density                                                                                                                                                                                                                                                                                                                                                                         | USDA 2005 (PMRA 2334762); (original study PMRA 1182368)                                      |
| Diatom<br><i>Navicula pelliculosa</i>                 | Acute, 96 h static        | Imidacloprid (formulated product 2F, 21.6% a.i.) | EC <sub>50</sub> = 12.37<br>NOEC = 6.69          | Cell density                                                                                                                                                                                                                                                                                                                                                                         | USDA 2005 (PMRA 2334762); (original study PMRA 1182367)                                      |
| <b>Vascular plants</b>                                |                           |                                                  |                                                  |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                              |
| Duckweed<br><i>Lemna gibba</i> G3                     | Acute, 7 d static renewal | Imidacloprid (98.8%)                             | EC <sub>50</sub> > 105                           | Frond count, cumulative biomass, growth rate                                                                                                                                                                                                                                                                                                                                         | PMRA 2146456                                                                                 |
| Duckweed<br><i>Lemna minor</i>                        | Acute, 7 d static         | Imidacloprid (Confidor 200 SC)                   | EC <sub>50</sub> = 740                           | Growth inhibition                                                                                                                                                                                                                                                                                                                                                                    | EFSA 2008 (PMRA 2332663); (original study (PMRA 2544387)                                     |

Table 27 Summary of aquatic field studies

| Study type                                                              | Tested species                                                                                   | Exposure                                                                                                                                                                                                 | Biological results                                                                                                                                                                                                                                                                                                                  | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Reference                                |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| <b>Lentic Systems</b>                                                   |                                                                                                  |                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                          |
| Freshwater outdoor mesocosm: 10 weeks. Establishment period – 3 weeks.  | insect larvae and emerged adult insects                                                          | Three applications at 1 week intervals at nominal concentrations of 0.6, 1.4, 3.2, 7.5, 17.3 and 40 µg a.i./L.<br>0.2, 0.4, 1.0, 2.3, 5.2, 12 µg/L TWA                                                   | <u>Total Chironomidae</u><br>NOEC (diversity and abundance) = 2.3 µg/L.<br><u>Orthocleidiinae and Tanypodina</u><br>NOEC (abundance) = 5.2 µg/L.<br><u>Caenis spp.</u><br>NOEC (emerged adults) 0.2 µg/L.<br>NOEC(abundance) = 2.3 µg/L.                                                                                            | Endpoints reported are based on TWA - time weighted average concentrations. Invertebrate sampling occurred only at test termination, recovery periods of the invertebrate communities for each exposure scenario were not determined.<br><br>EFSA states that it is unclear at the 0.2 µg/L concentration whether emerged adult <i>Caenis</i> spp. were present; statistical power might be low at 0.4 µg/L.                                                                                                                                                                                                                                | Columbo and Mohr, 2013; PMRA 2358287     |
| Freshwater outdoor mesocosm: 119 days. Establishment period – 6 months. | Multiplespecies: phytoplankton, zooplankton, macroinvertebrates, emerged insects                 | Two applications with a 21 day interval at nominal concentrations of 0, 0.6, 1.5, 3.8, 9.4 and 23.5 µg a.i./L.                                                                                           | <u>Macrozoobenthos</u><br>(abundance, diversity, adult emergence)<br>NOEC (Chironomid and Bactidae) = 0.6 µg /L.<br>NOEAEC (macrozoobenthos) = 9.4 µg/L.<br><u>Zooplankton</u><br>NOEC (Chaoborus) = 3.8 µg/L.<br>NOEC (Copepods and cladocerans) = 9.4 µg/L.<br>NOEAEC = 23.5 µg/L.<br><u>Phytoplankton</u><br>NOEAEC = 23.5 µg/L. | Recovery (macrozoobenthos and zooplankton) occurred within eight weeks after the last application. However, it is not possible to draw a clear conclusion of the recovery of mayfly species (Ephemeroptera - bactidae) because they were present in too low abundance to allow a reliable statistical evaluation (low statistical power – no Ephemeroptera were observed at the beginning of the study up to 63 days). The NOEC of 0.6 µg a.i./L is considered insufficient to cover sensitive species such as Ephemeroptera.<br><br>Two applications (21 day interval) may not be representative of a most conservative exposure scenario. | PMRA 2142729                             |
| Freshwater microcosms: 19 weeks                                         | Multiplespecies: phytoplankton, zooplankton, macroinvertebrates, including <i>Hyaella azteca</i> | Four surface applications at 2- week intervals at nominal concentrations of 0, 2.0, 6.0, 20, 60 and 180 µg a.i./L (average measured concentrations 0, 1.5, 4.7, 19, 58 and 180 µg a.i./L, respectively). | <u>Macroinvertebrates</u><br>NOEC = 6.0 (4.7 measured) µg/L.<br>NOEAEC = 6.0 (4.7 measured) µg/L. (adult emergence)<br><u>Zooplankton</u><br>NOEC = 6.0 (4.7 measured) µg/L (copepod abundance)<br>NOEAEC ≥ 180 µg/L (total zooplankton density and species richness)<br><u>Phytoplankton</u><br>NOEC ≥ 180 µg/L.                   | The USDA 2005 review of imidacloprid reports a lower NOEAEC for macroinvertebrate (2.0 µg/L) and a LOEC of 2.0 µg/L for <i>Hyaella azteca</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | USDA 2005; (original study PMRA 1155896) |

| Study type                                                                 | Tested species                                                                              | Exposure                                                                                                                                         | Biological results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Comments | Reference                                                    |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------|
|                                                                            |                                                                                             |                                                                                                                                                  | <i>Hyalella arctica</i><br>NOEC = 6.0 µg/L<br><i>Caenidae</i><br>NOEC = 2.0 µg/L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |                                                              |
| Experimental rice paddy mesocosms: 4 months in each of 2 consecutive years | Multispecies: juvenile and adult medaka fish ( <i>Oryzias latipes</i> ), macroinvertebrates | Transplant of treated rice seedlings to paddies in spring of 2010 and 2011; seedlings treated 24-h before transplanting, at a rate of 100 g/box. | <p>Maximum concentration of imidacloprid in water was 49 and 39 µg/L at 2-h after transplanting of rice seedlings in 2010 and 2011, respectively. The concentration declined rapidly to 1.0 µg/L in 3 days (DT<sub>50</sub> = 6.7 and 14.1 days, respectively). DT<sub>50</sub>s in soil were 14 and 36 days in 2010 and 2011, respectively.</p> <p>No examination of the species composition and structure within mesocosms prior to treatment, therefore, any pre-existing differences between mesocosm communities is unknown. Variable changes were observed in community composition and structure relative to the control over the study periods (2010 and 2011); relatively-small changes of the aquatic community structure were found between controls and imidacloprid treated mesocosms two months after the insecticide application in 2010, the changes were much greater after the 2011 application and persisted throughout the sampling period.</p> <p>Recovery of the zooplankton community in both treated paddies occurred within 3 months (Fig. 2a from study), nekton communities, mainly water striders and shore bugs (Fig. 2c), nekton communities of long-lived species such as dragonfly larvae and tadpoles (Fig. 2d) and benthic communities, mainly chironomidae larvae (Fig. 2e), did not recover until the end of the experimental period.</p> <p>The body size of adult medaka fish as well as that of their fries was periodically significantly smaller in the imidacloprid treated fields than in the control field; these observances may be indirectly related to imidacloprid effects on Medaka food sources (zooplankton abundance).</p> <p>Only one exposure concentration was tested and the manner of imidacloprid introduction to the mesocosms (rice seedling treatment followed by transplant) is not applicable to the Canadian use pattern.</p> |          | Hayasaka <i>et al.</i> 2011, 2012 (PMRA 2544538 and 2544539) |
| Freshwater microcosm: 37 days after 1 <sup>st</sup> application            | Mayfly <i>Cloen dipterum</i>                                                                | Two applications with a 21 day interval at nominal concentrations of 0, 0.097, 0.243, 0.608, 1.52 and 3.8 µg a.i./L.                             | <p>NOEC = 1.52 µg/L; this NOEC is suggested by authors based on reduced <i>C. dipterum</i> abundance in only one of three mesocosms observed at 3.8 µg/L; statistically, however, the effect was not significant.</p> <p>EFSA disagrees to consider the endpoint as NOEC<sub>population</sub> because: only effects on one species of mayfly, i.e., <i>C. dipterum</i> were considered; no further effects on population /community level were investigated. <i>C. dipterum</i> is reported to be a multivoltine species with approximately three generation per year; therefore, species with less possibility to recover were not covered.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          | EFSA 2014 (PMRA 2545413); Roessink and Hartgers, 2014.       |

| Study type                                     | Tested species                                                  | Exposure                                                                                                                                                                   | Biological results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                       | Reference                                                             |
|------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Freshwater mesocosm; 8 weeks                   | Macroinvertebrate community, zooplankton, phytoplankton         | Two applications with a 21 day interval at nominal concentrations of 0, 0.6, 0.8, 1.1, 3.3 and 10 µg/L.                                                                    | <u>Chironomidae (emerging insects)</u><br>NOEC (community) = 1.1 µg/L.<br>NOEC ( <i>Chironomus crystallinus</i> ) = 1.1 µg/L.<br>NOEAEC = 1.1 µg/L.<br><u>Chironomidae (larval abundance)</u><br>NOEC = 0.6 µg/L ( <i>Chironomus</i> and <i>Tanytarsini</i> )<br>NOEAEC = 1.1 µg/L.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The most sensitive group of organisms belonged to Chironominae. No Ephemeroptera were observed up to 35 days after the first application. The reported NOEC of 0.6 µg a.i./L (lowest test concentration) may not be sufficient to cover sensitive species such as Ephemeroptera, due to the uncertainty as to whether effects occur at lower concentrations.<br><br>Note: Effects for zooplankton and phytoplankton not reported in EFSA 2014. | EFSA 2014 (PMRA 2545413); Hammers-Wirtz, Strauss & Mammert, May 2009  |
| Freshwater mesocosm                            | Macroinvertebrate community, zooplankton, phytoplankton         | Two applications with a 21 day interval at nominal concentrations of 0, 0.5, 0.75, 1.1, 2.4 and 4.8 µg/L.                                                                  | The authors concluded that the overall lowest NOEC for the emerging insects would be below the lowest test concentration (< 0.5 µg a.s./L, nominal). EFSA noted that the same deficiencies as those highlighted for the previous study (Nufarm, Report No: B07683, May 2009) were observed also for this study (i.e., no Ephemeroptera were observed in the samples up to 49 days after the first application).<br><br>Note: Effects for zooplankton and phytoplankton not reported in EFSA 2014.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                | EFSA 2014 (PMRA 2545413); Hammers-Wirtz, Strauss & Mammert, July 2009 |
| Experimental rice paddy mesocosms; 118 days    | Adult and juvenile medaka ( <i>Oryzias latipes</i> )            | Transplant of treated rice seedlings to field treated with Admire GR (1% imidacloprid) at 215 g a.i./ha.                                                                   | The results indicate that exposure to imidacloprid may cause increased physiological stress to juvenile fish (medaka) as a result of increased parasitic infestation. Mortality was 5% and 0% in the treated and control fields within the first 4 days. Further losses of fish in subsequent weeks could not be attributed to the acute toxicity due to the suspected influence of predation (i.e., black-crowned night herons visiting the experimental fields at night was reported). Only one exposure concentration was tested (i.e., a NOEC was not determined).                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                | Sanchez-Bayo and Goka, 2005 (PMRA 2544544)                            |
|                                                | Macroinvertebrate community, zooplankton, benthic invertebrates |                                                                                                                                                                            | The zooplankton community was absent during the early exposure phase, a period coinciding with water concentrations above 1 µg a.i./L. Zooplankton took more than 2 months to reappear and did not recover in abundance by the end of the study. The lack of primary consumers resulted in green algae blooms ( <i>Spirogyra</i> sp.).<br><br>The benthic community was practically absent during the first 3 weeks after transplant; benthos (mainly midge larvae - <i>Chironomus</i> sp.) recovered after 5 weeks with the exception of one species of midge larvae ( <i>C. yoshimatsui</i> ) which was completely absent for two months. Residues in soil were variable of the study period ranging from 1.6 to 24.7 µg a.i./kg dw).<br><br>Diversity was significantly lower at 2 weeks to approximately 1 month after planting than that of control fields; this period coincided with the time that water concentrations were greater than 1 µg/L. Only one exposure concentration was tested (i.e., a NOEC was not determined). |                                                                                                                                                                                                                                                                                                                                                                                                                                                | Sanchez-Bayo and Goka, 2006 (PMRA 2574054)                            |
| <b>Lotic systems</b>                           |                                                                 |                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                       |
| Freshwater artificial stream mesocosm; 20 days | Macroinvertebrate community                                     | Three pulses (24-h duration) of imidacloprid (2.0 and 20 mg/L) every 7 days.<br><br>Average peak concentrations measuring during the 24-h pulses were 1.63 and 17.60 µg/L. | <u>Invertebrate abundance and diversity</u><br>NOEC = 2.0 µg/L (1.63 µg/L measured)<br><u>EPT (Ephemeroptera/ Plecoptera and Tricoptera - abundance)</u><br>NOEC < 2.0 µg/L (1.63 µg/L measured)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Only two exposure concentrations were tested in mesocosm experiments. Ephemeroptera were particularly sensitive at the high imidacloprid concentration; the lowest concentration caused a reduction of 30% on EPT taxa abundance.                                                                                                                                                                                                              | Pestana <i>et al.</i> 2009 (PMRA 2544389)                             |



| Study type                                      | Tested species                                                               | Exposure                                                                                                                        | Biological results                                                                                                                                                                                                                                                                                                                                                                                                                                                | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Reference                                   |
|-------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Freshwater artificial stream mesocosm: 20 days  | Species: <i>Epeorus</i> spp. (Heptageniidae) and <i>Baetis</i> spp.; mayfly. | Two exposure regimes: pulse (12h): 0, 0.1, 0.5, 1.5 and 10 µg/L and continuous: 0, 0.1, 0.5, and 1 µg/L                         | <u>Under continuous exposure:</u><br>NOEC < 0.1 µg/L head length in <i>Baetid</i> and thorax length in <i>Epeorus</i><br>NOEC = 0.3 µg/L (nymph density – both species)<br>NOEC ≥ 9.1 µg/L (emergence – <i>Baetid</i> )<br>NOEC = 0.1 µg/L (emergence – Heptageniidae)<br><u>Pulse exposure:</u><br>NOEC = 3.9 µg/L (nymph density – Heptageniidae)<br>NOEC ≥ 9.1 µg/L (nymph density, emergence – <i>Baetid</i> )<br>NOEC = 3.9 µg/L (emergence – Heptageniidae) | Effects were observed for two species of mayfly only; population/community level effects were not measured. As invertebrate sampling occurred only at test termination, recovery periods were not determined.<br><br>The implications of impaired development and growth on reproductive success in mayflies should not be discounted. The authors concluded that “sublethal doses of this widely applied agricultural insecticide have the potential to reduce reproductive success of mayfly populations...”, and “streams dependant on insect processing to maintain function may be seriously impacted.” | Alexander <i>et al.</i> 2008 (PMRA 2545402) |
| Freshwater artificial stream mesocosm: 70 days  | Species: Amphipod ( <i>Gammarus roeseli</i> )                                | 12 µg imidacloprid/L for 12 h overnight; 2 pulse series were conducted in sum with 1 pulse series consisting of 3 weekly pulses | NOEC ≥ 12 µg/L based on shredder efficiency and mortality<br><br>The number of brood carrying females was reduced in the treatments compared to the control groups in the last 3 weeks of study.                                                                                                                                                                                                                                                                  | Effects were observed for the pulse concentration (12 µg/L) but no lower concentrations were tested; no direct conclusion can be drawn on the effect threshold. The study is not useful in terms of a risk assessment.                                                                                                                                                                                                                                                                                                                                                                                       | Böttger <i>et al.</i> 2013, (PMRA 2545404)  |
| Freshwater artificial stream mesocosm: 11 weeks | Multispecies: Macroinvertebrate community                                    | Two application series (spring and summer) of three successive 12 hour pulses of imidacloprid (12 µg a.i./L)                    | The caddisfly species <i>Neureclipsis</i> sp. reacted immediately and most sensitively after a single imidacloprid pulse whilst insect larvae such as ephemeroptera (mainly <i>Caenis</i> sp. and <i>Baetis</i> sp.) and dipteran larvae (Tanypodinae, Tanytarsini) were negatively affected only after repeated imidacloprid pulses.<br><br>NOEC < 12 µg a.i./L                                                                                                  | A NOEC could not be determined, however, it is <12 µg/L, the only exposure concentration tested. Recovery periods for invertebrates after the last application of each treatment were not determined.                                                                                                                                                                                                                                                                                                                                                                                                        | Mohr <i>et al.</i> 2012, (PMRA 2544540)     |
| Freshwater artificial stream mesocosm: 11 weeks | Species: <i>Gammarus roeseli</i> and <i>Baetis fuscatus</i>                  | Two application series (spring and summer) of three successive 12 hour pulses of imidacloprid (12 µg a.i./L) one week apart.    | 12 h pulses of 12 µg/L imidacloprid provoked taxon-specific, immediate, and pronounced increases in the drift of insect larvae and <i>G. roeseli</i> < 3.8 mm and a pulse by pulse decrease in activity of exposed adult <i>G. roeseli</i> . NOEC (drift) < 12 µg a.i./L.                                                                                                                                                                                         | A NOEC could not be determined, however, it is <12 µg/L, the only exposure concentration tested.<br><br>The results demonstrate that drift is a sensitive sub-lethal ecologically relevant endpoint for macroinvertebrates exposed to pulses of imidacloprid (at 12 µg/L) under highly controlled conditions simulating a lotic environment. This effect is within the range of other sublethal effects observed in aquatic macroinvertebrates.                                                                                                                                                              | Berghahn <i>et al.</i> 2012, (PMRA 2544551) |

| Study type                                      | Tested species                                                                  | Exposure                                                                                                                                                                                                                     | Biological results                                                                                                                                                                                                                                                                                                                                     | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Reference                                   |
|-------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Outdoor streams: Georgia and North Carolina     | Multiple species: Macroinvertebrate community                                   | Merit 75WSP (purity not reported)<br>Soil injection or trunk injection of imidacloprid for hemlock woolly adelgid control near streams (4 stream sites and a control site)<br><br>Imidacloprid injection in November and May | No treatment-related changes in aquatic invertebrates were observed.<br><br><1.0 ppb imidacloprid was measured in water samples. Imidacloprid was only detected once at day 720 after treatment at 1.0 µg/L.                                                                                                                                           | The short term impact on aquatic invertebrates was not adequately assessed; only one site was sampled shortly two weeks after treatment.<br><br>After two weeks post-treatment, significant recolonization from upstream areas as well as other vectors (i.e., migration from downstream, egg-laying by aerial adults and recolonization from areas within the stream) may have prevented any observable short-term impact to macroinvertebrates at the North Carolina treatment site. The other three Georgian sites were sampled five months after treatment. | Churchel <i>et al.</i> 2011, (PMRA 2544550) |
| Freshwater artificial stream mesocosm: 48 hours | Species: amphipod <i>Gammarus pulex</i> and mayfly larvae <i>Baetis rhodani</i> | Imidacloprid (purity not reported)<br><br>One application at nominal concentrations of 1 (0.97 µg a.i./L measured 1 hour after application) and 30 µg a.i./L.                                                                | NOEC (drift) < 1 µg a.i./L in <i>B. rhodani</i> and <i>G. pulex</i> ; no mortality was reported.<br><br>Drift of test animals was detected within 2 h after exposure. Maximum drift percentages were detected 4 h after contamination. During subsequent observation periods (22–48 h after contamination) the drift responses became less pronounced. | The results of this study are similar to those reported in Berghahn <i>et al.</i> 2012, with the exception that the current study examined drift behaviour from a single exposure rather than pulsed exposure.                                                                                                                                                                                                                                                                                                                                                  | Beketov and Liess 2008, (PMRA 2544548)      |

Table 28 Effects of imidacloprid on marine invertebrates

| Organism                                                                                | Exposure                      | Test Substance               | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                                                               | Comments                                                                                       | Reference                                               |
|-----------------------------------------------------------------------------------------|-------------------------------|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| <i>Artemia</i> sp., and Mosquito ( <i>Aedes taeniorhynchus</i> )                        | Acute, 48 h static            | Imidacloprid (>95%)          | 48h LC <sub>50</sub> = <b>361.23</b> (Artemia)<br>48h LC <sub>50</sub> = <b>0.15</b> (Mosquito)                                          | Note: increasing salinity increased sensitivity to imidacloprid. From Song <i>et al.</i> 1997. | USDA 2005 (PMRA 2334762)                                |
| Marine mysid<br><i>Mysidopsis bahia</i> , also referred to as <i>Americamysis bahia</i> | Acute, 96 h<br>(flow-through) | Imidacloprid (96.2%)         | 96h LC <sub>50</sub> = <b>0.0377</b> (1 <sup>st</sup> test)<br>96h LC <sub>50</sub> = <b>0.0341</b> (2 <sup>nd</sup> test) NOEC = 0.0133 | 1 <sup>st</sup> test: NOEC was not determined within the test concentration range.             | USDA 2005 (PMRA 2334762); (original study PMRA 1155858) |
|                                                                                         |                               | Imidacloprid (240 FS, 22.7%) | 96h LC <sub>50</sub> = <b>0.036</b><br>NOEC = 0.021                                                                                      |                                                                                                | USDA 2005 (PMRA 2334762); (original study PMRA 1155860) |

| Organism                                       | Exposure                      | Test Substance                                  | Endpoint Value <sup>a</sup><br>(mg a.i./L)                                                                                                                                                                                                                                | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Reference                                                  |
|------------------------------------------------|-------------------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Eastern Oyster<br><i>Crassostrea virginica</i> | Acute, 96 h<br>(flow-through) | Imidacloprid<br>(95.8 – 96.2%)                  | 96h EC <sub>50</sub> > <b>23.3</b> (1 <sup>st</sup> test)<br>EC <sub>50</sub> > 145 (2 <sup>nd</sup> test – limit test)                                                                                                                                                   | 100% survival; no effects on shell growth in first test. New shell growth of exposed was 22% less than controls in 2 <sup>nd</sup> test – limit test. EFSA states that the second test is not valid due to increase in shell thickness of the controls below the 2mm (1.52 – 1.72mm).                                                                                                                                                                                                                                                                                       | USDA 2005 (PMRA 2334762);<br>EFSA 2014 (PMRA 2545413)      |
| Marine mysid<br><i>Mysidopsis bahia</i>        | Chronic, 28d flow-through     | Imidacloprid (96.2%)                            | NOEC = 0.00056 (1 <sup>st</sup> test; based on reduced number of offspring/female reproductive day)<br>NOEC = 0.000326 (2 <sup>nd</sup> test; based on reduced growth of first generation as length and as dry weight)                                                    | <b>First Test:</b> At 0.005 mg/L and higher: significantly reduced growth of first generation mysids as total length and as dry weight. At 0.01 mg/L: statistically increased mortality in comparison with pooled controls for first generation. No effects on mortality in second generation.<br><b>Second test:</b> At 0.0006 mg/L: statistically increased mortality in comparison with pooled controls for first generation. No effects on mortality in second generation.<br>No real explanation for discrepancy between first and second tests with regard to growth. | USDA 2005 (PMRA 2334762);<br>(original study PMRA 1155862) |
| Blue crab<br><i>Callinectes sapidus</i>        | Acute, 24 h (static)          | Imidacloprid (99.5%)<br><br>Trimax® Pro (40.8%) | <u>Imidacloprid</u><br>Megalopae (post larval stage) 24h LC <sub>50</sub> = <b>0.010</b><br>Juvenile 24h LC <sub>50</sub> = 1.112<br><br><u>Trimax® Pro</u><br>Megalopae (post larval stage) 24h LC <sub>50</sub> = <b>0.313</b><br>Juvenile 24h LC <sub>50</sub> = 0.817 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Osterberg <i>et al.</i> 2012, (PMRA 2544541)               |
| Grass shrimp<br><i>Palaemonetes pugio</i>      | Acute, 96 h (static renewal)  | Imidacloprid (99.5%)                            | Larvae (2d old): 96h LC <sub>50</sub> = <b>0.309</b><br>Adult: 96h LC <sub>50</sub> = <b>0.564</b>                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Key <i>et al.</i> 2007, (PMRA 2544540)                     |

<sup>a</sup> Endpoints in bold were used to determine acute HC<sub>5</sub> value (the 5<sup>th</sup> percentile of the species sensitivity distribution for the LC<sub>50</sub> at 50% confidence intervals); geometric mean values were used for species with multiple endpoint values. Acute HC<sub>5</sub> = 1.37 µg a.i./L.

**Table 29 Summary of screening level risk of imidacloprid to aquatic organisms exposed at the highest seasonal application rate for crop group 9 (curcurbit vegetables – 586.9 g a.i./ha)**

| Organism                   | Exposure | Species                                                 | Endpoint reported<br>(µg a.i./L) | Endpoint for<br>RA*<br>(µg a.i./L) | EEC**<br>(µg a.i./L) | RQ   | LOC<br>Exceeded |
|----------------------------|----------|---------------------------------------------------------|----------------------------------|------------------------------------|----------------------|------|-----------------|
| Freshwater organisms       |          |                                                         |                                  |                                    |                      |      |                 |
| Invertebrate               | Acute    | 32 invertebrate species                                 | HC <sub>5</sub> = 0.36           | 0.36                               | 73.4                 | 203  | Yes             |
|                            | Chronic  | 9 invertebrate species                                  | HC <sub>5</sub> = 0.041          | 0.021                              |                      | 1790 | Yes             |
| Fish                       | Acute    | Zebrafish<br><i>Danio rerio</i>                         | 96 h LC <sub>50</sub> = 17800    | 1780                               |                      | <0.1 | No              |
|                            | Chronic  | Rainbow trout<br><i>Onchorynchus mykiss</i>             | 98 d ELS<br>NOEC = 1200          | 1200                               |                      | <0.1 | No              |
| Amphibian                  | Acute    | Paddy field frog (tadpoles)<br><i>Rana limnocharis</i>  | 96 h LC <sub>50</sub> = 82000    | 8200                               | 391                  | <0.1 | No              |
|                            | Chronic  | African clawed-frog (tadpoles)<br><i>Xenopus Laevis</i> | 21 day NOEC = 3700               | 3700                               |                      | 0.1  | No              |
| Algae                      | Acute    | Diatom<br><i>Navicula pelliculosa</i>                   | 96h EC <sub>50</sub> = 12370     | 6185                               | 73.4                 | <0.1 | No              |
| Aquatic vascular plant     | Acute    | Duckweed<br><i>Lemna gibba</i> G3                       | 7d EC <sub>50</sub> > 105000     | >52500                             |                      | <0.1 | No              |
| Marine/Estuarine organisms |          |                                                         |                                  |                                    |                      |      |                 |
| Invertebrate               | Acute    | 6 invertebrate species                                  | HC <sub>5</sub> = 1.37           | 1.37                               | 73.4                 | 54   | Yes             |
|                            | Chronic  | Marine mysid<br><i>Mysidopsis bahia</i>                 | 28d NOEC = 0.33                  | 0.33                               |                      | 222  | Yes             |



| Organism     | Exposure      | Species                                           | Endpoint reported<br>(µg a.i./L) | Endpoint for<br>RA*<br>(µg a.i./L) | EEC**<br>(µg a.i./L) | RQ   | LOC<br>Exceeded |
|--------------|---------------|---------------------------------------------------|----------------------------------|------------------------------------|----------------------|------|-----------------|
| Fish         | Acute         | Sheepshead minnow<br><i>Cyprinodon variegatus</i> | 96 h LC <sub>50</sub> = 161000   | 16100                              |                      | <0.1 | No              |
|              | Chronic       | Not available                                     |                                  |                                    |                      |      |                 |
| Marine algae | Not available |                                                   |                                  |                                    |                      |      |                 |

\* Endpoints used in the acute exposure risk assessment (RA) are derived by dividing the EC<sub>50</sub> or LC<sub>50</sub> from the appropriate laboratory study by a factor of two (2) for aquatic invertebrates and plants, and by a factor of ten (10) for fish and amphibians. The HC<sub>5</sub> is the 5<sup>th</sup> percentile of the species sensitivity distribution for the LC<sub>50</sub> or EC<sub>50</sub> at 50% confidence intervals.

\*\*EEC based on a 15 cm water body depth for amphibians and a 80 cm water depth for all other aquatic organisms.

Bolded values indicates an exceedence of the level of concern (RQ = 1).

**Table 30 Spray drift risk assessment for non-target aquatic organisms**

| Organism                       | Exposure | Species                                 | Endpoint reported<br>(µg a.i./L) | Endpoint for RA <sup>1</sup><br>(µg a.i./L) | Use Scenario | Application rate <sup>2</sup><br>(g a.i./ha) | EEC<br>(µg a.i./L) | RQ         | LOC exceeded |
|--------------------------------|----------|-----------------------------------------|----------------------------------|---------------------------------------------|--------------|----------------------------------------------|--------------------|------------|--------------|
| Invertebrate                   | Acute    | 32 invertebrate species                 | HC <sub>5</sub> = 0.36           | 0.36                                        | Soybean      | 2.68                                         | 0.34               | <b>0.9</b> | No           |
|                                |          |                                         |                                  |                                             | Raspberry    | 242                                          | 30                 | <b>83</b>  | Yes          |
|                                | Chronic  | 10 invertebrate species                 | HC <sub>5</sub> = 0.041          | 0.041                                       | Soybean      | 2.68                                         | 0.34               | <b>8.3</b> | Yes          |
|                                |          |                                         |                                  |                                             | Raspberry    | 242                                          | 30                 | <b>732</b> | Yes          |
| Marine /estuarine invertebrate | Acute    | 6 invertebrate species                  | HC <sub>5</sub> = 1.37           | 1.37                                        | Soybean      | 2.68                                         | 0.34               | 0.2        | No           |
|                                |          |                                         |                                  |                                             | Raspberry    | 242                                          | 30                 | <b>22</b>  | Yes          |
|                                | Chronic  | Marine mysid<br><i>Mysidopsis bahia</i> | 28d NOEC = 0.33                  | 0.33                                        | Soybean      | 2.68                                         | 0.34               | <b>1.0</b> | Yes          |
|                                |          |                                         |                                  |                                             | Raspberry    | 242                                          | 30                 | <b>91</b>  | Yes          |

Bolded values indicates an exceedence of the level of concern (RQ = 1).

<sup>1</sup> The HC<sub>5</sub> is the 5<sup>th</sup> percentile of the species sensitivity distribution for the LC<sub>50</sub> or EC<sub>50</sub> at 50% confidence intervals

<sup>2</sup> The assessment of potential risk from drift was assessed for the minimum single ground application for soybean (24.4 g a.i./ha) and the maximum cumulative application rate for early airblast application for raspberry (112 g a.i./ha × 3 at 7-day intervals); these application rates cover the full range of application rates and application.

<sup>3</sup> The maximum amount of spray that is expected to drift 1m downwind from the application site during spraying using field sprayer and airblast application method was determined based on a fine spray droplet size, 11% and 74%, respectively. The aquatic EEC for the highest cumulative application rate was revised by adjusting the sum of the applications for dissipation between applications using the 80<sup>th</sup> percentile of three aquatic whole-system representative half-life values (191 days).

**Table 31 Level 1 aquatic ecoscenario modelling EECs for imidacloprid in 0.8-m wetland**

| Region                | EEC (µg a.i./L)<br>in overlying water |         |        |        |        |        | EEC (µg a.i./L)<br>in Pore water |        |
|-----------------------|---------------------------------------|---------|--------|--------|--------|--------|----------------------------------|--------|
|                       | Peak                                  | 96-hour | 21-day | 60-day | 90-day | Yearly | Peak                             | 21-day |
| 1 × 0.5869 kg a.i./ha |                                       |         |        |        |        |        |                                  |        |
| BC                    | 20                                    | 16.5    | 8.89   | 3.62   | 2.44   | 0.60   | 3.2                              | 2.8    |
| Prairies              | 20                                    | 16.8    | 8.59   | 3.49   | 2.34   | 0.58   | 3.1                              | 2.6    |
| ON                    | 21                                    | 17.2    | 8.82   | 3.56   | 2.39   | 0.59   | 3.2                              | 2.7    |
| QC                    | 13                                    | 10.8    | 5.52   | 2.26   | 1.52   | 0.38   | 2.0                              | 1.6    |
| Atlantic              | 52                                    | 45.7    | 24.9   | 10.1   | 6.83   | 1.7    | 9.3                              | 8.2    |
| 1 × 0.0205 kg a.i./ha |                                       |         |        |        |        |        |                                  |        |
| BC                    | 0.69                                  | 0.58    | 0.31   | 0.13   | 0.085  | 0.021  | 0.081                            | 0.077  |
| Prairies              | 0.71                                  | 0.59    | 0.30   | 0.12   | 0.082  | 0.020  | 0.075                            | 0.070  |
| ON                    | 0.73                                  | 0.60    | 0.31   | 0.12   | 0.084  | 0.021  | 0.078                            | 0.073  |
| QC                    | 0.46                                  | 0.38    | 0.19   | 0.079  | 0.053  | 0.013  | 0.047                            | 0.044  |
| Atlantic              | 1.8                                   | 1.6     | 0.87   | 0.35   | 0.24   | 0.059  | 0.024                            | 0.23   |

**Table 32 Level 1 aquatic ecoscenario modelling EECs for imidacloprid in the overlying water of a 0.15-m wetland**

| Region                | EEC (µg a.i./L) |         |        |        |        |        |
|-----------------------|-----------------|---------|--------|--------|--------|--------|
|                       | Peak            | 96-hour | 21-day | 60-day | 90-day | Yearly |
| 1 × 0.5869 kg a.i./ha |                 |         |        |        |        |        |
| BC                    | 105             | 45.7    | 10.4   | 3.7    | 2.48   | 0.61   |
| Prairies              | 106             | 44.9    | 10.1   | 3.57   | 2.39   | 0.59   |
| ON                    | 101             | 46.8    | 10.3   | 3.65   | 2.44   | 0.60   |
| QC                    | 64              | 29.4    | 6.45   | 2.32   | 1.55   | 0.38   |
| Atlantic              | 247             | 128     | 29     | 10.3   | 6.91   | 1.7    |
| 1 × 0.0205 kg a.i./ha |                 |         |        |        |        |        |
| BC                    | 3.7             | 1.6     | 0.36   | 0.13   | 0.087  | 0.021  |
| Prairies              | 1.7             | 0.87    | 0.20   | 0.069  | 0.046  | 0.012  |

| Region   | EEC ( $\mu\text{g a.i./L}$ ) |         |        |        |        |        |
|----------|------------------------------|---------|--------|--------|--------|--------|
|          | Peak                         | 96-hour | 21-day | 60-day | 90-day | Yearly |
| ON       | 3.5                          | 1.6     | 0.36   | 0.13   | 0.085  | 0.021  |
| QC       | 2.2                          | 1.0     | 0.23   | 0.081  | 0.054  | 0.013  |
| Atlantic | 8.3                          | 4.4     | 1      | 0.358  | 0.241  | 0.062  |

Table 33 Refined risk assessment of imidacloprid for aquatic organisms from predicted run-off

| Organism                       | Exposure | Species                                 | Endpoint reported ( $\mu\text{g a.i./L}$ ) | Endpoint for RA* ( $\mu\text{g a.i./L}$ ) | Use Rate** (g a.i./ha) | EEC*** ( $\mu\text{g a.i./L}$ ) | RQ          | LOC exceeded |
|--------------------------------|----------|-----------------------------------------|--------------------------------------------|-------------------------------------------|------------------------|---------------------------------|-------------|--------------|
| Invertebrate                   | Acute    | 32 invertebrate species                 | $\text{HC}_5 = 0.36$                       | 0.36                                      | 20.5                   | 1.8                             | <b>5.04</b> | Yes          |
|                                |          |                                         |                                            |                                           | 586.9                  | 52                              | <b>144</b>  | Yes          |
|                                | Chronic  | 10 invertebrate species                 | $\text{HC}_5 = 0.041$                      | 0.041                                     | 20.5                   | 0.87                            | <b>21.2</b> | Yes          |
|                                |          |                                         |                                            |                                           | 586.9                  | 24.9                            | <b>607</b>  | Yes          |
| Marine /estuarine invertebrate | Acute    | 6 invertebrate species                  | $\text{HC}_5 = 1.37$                       | 1.37                                      | 20.5                   | 1.8                             | <b>1.3</b>  | Yes          |
|                                |          |                                         |                                            |                                           | 586.9                  | 52                              | <b>38</b>   | Yes          |
|                                | Chronic  | Marine mysid<br><i>Mysidopsis bahia</i> | 28d NOEC = 0.33                            | 0.33                                      | 20.5                   | 0.87                            | <b>2.6</b>  | Yes          |
|                                |          |                                         |                                            |                                           | 586.9                  | 24.9                            | <b>75</b>   | Yes          |

Bolded values indicates an exceedence of the level of concern ( $\text{RQ} = 1$ ).

\* The  $\text{HC}_5$  is the 5<sup>th</sup> percentile of the species sensitivity distribution for the  $\text{LC}_{50}$  or  $\text{EC}_{50}$  at 50% confidence intervals.

\*\* Application rate represents the minimum and maximum applications rates.

\*\*\* EEC based on an 80 cm water depth. The acute and chronic endpoints for invertebrates are based on data with 48 hour and approximately 21 day exposure periods, respectively; for these endpoints, the RQ values shown are based on the peak and 21 day EECs.

Table 34 Refined risk assessment of imidacloprid for aquatic organisms using Canadian monitoring data

| Organism                          | Exposure | Species                                 | Endpoint reported<br>( $\mu\text{g a.i./L}$ ) | Endpoint for RA*<br>( $\mu\text{g a.i./L}$ ) | EEC** ( $\mu\text{g a.i./L}$ )                                    | RQ        | LOC<br>exceeded |
|-----------------------------------|----------|-----------------------------------------|-----------------------------------------------|----------------------------------------------|-------------------------------------------------------------------|-----------|-----------------|
| Invertebrate                      | Acute    | 32 invertebrate species                 | $\text{HC}_5 = 0.36$                          | 0.36                                         | 11.9                                                              | <b>33</b> | Yes             |
|                                   | Chronic  | 9 invertebrate species                  | $\text{HC}_5 = 0.041$                         | 0.041                                        | 1.26                                                              | <b>31</b> | Yes             |
| Marine /estuarine<br>invertebrate | Acute    | 6 invertebrate species                  | $\text{HC}_5 = 1.37$                          | 1.37                                         | Monitoring data are not robust enough to use in a risk assessment |           |                 |
|                                   | Chronic  | Marine mysid<br><i>Mysidopsis bahia</i> | 28d NOEC = 0.33                               | 0.33                                         | Monitoring data are not robust enough to use in a risk assessment |           |                 |

Bolded values indicates an exceedence of the level of concern (RQ = 1).

\* The  $\text{HC}_5$  is the 5<sup>th</sup> percentile of the species sensitivity distribution for the  $\text{LC}_{50}$  or  $\text{EC}_{50}$  at 50% confidence intervals.

\*\* EEC based on monitoring data.





## Appendix X Water monitoring data

A total of approximately 11,350 samples were analyzed for imidacloprid in water from both agricultural and urban areas of Canada and the United States. Transformation products imidacloprid-urea, imidacloprid-guanidine and imidacloprid-olefin were analyzed in a total of 362 surface water samples from agricultural areas in Quebec. The available data for imidacloprid spanned from 1995 to 2014, while data for imidacloprid transformation products were available for the years 2005 to 2014.

Monitoring data likely provide an underestimate of actual exposure, as sampling typically does not capture peak concentrations.

Non-detections can be difficult to interpret, particularly when the limit of detection is high, and when use information in the vicinity of sampling areas is not available. The non-detects could be due to factors such as the non-transport of the chemical from the site of application, the lack of use of the chemical in the area studied, or to the lack of sensitivity of the analytical method.

Available Canadian and American water monitoring data on imidacloprid and its transformation products in surface water bodies relevant for a PMRA aquatic risk assessment are presented in Tables 1 and 2. A summary of the data follows.

### *Freshwater*

Imidacloprid is routinely detected in surface water from both agricultural and urban areas in Canada and the United States. Overall, it was detected in 15% of the approximately 11,350 samples. At a more local scale, imidacloprid was detected in 68% of 355 surface water samples collected in agricultural areas of Quebec between 2010 and 2014 (PMRA# 2523837, 2544468, 2561884), in 100% of seven samples collected from a creek located in a potato and vegetable growing area of Quebec in 2005 and 2006 (PMRA# 2035772), and in 86% of 470 surface water (mainly streams) samples from agricultural areas of Ontario between 2011 and 2014 (PMRA# 2526820, 2523839, 2532563). In an urban area of California, Ensminger *et al.* (PMRA# 2526150) detected imidacloprid in 51% of 45 surface water samples analyzed between 2008 and 2011. Imidacloprid was detected in 80% of ten creeks located in urban, agricultural or mixed urban and agricultural settings (PMRA# 2566514).

The maximum concentration of imidacloprid detected in surface water was 25 µg/L based on a pond water sample from a golf course in a rural area of Maryland (PMRA# 2538821). It is worth noting that imidacloprid was detected at concentrations exceeding 1 µg/L in several Canadian and American sites located in both agricultural and urban areas. For instance, it was detected at up to 11.9 µg/L in runoff from a potato growing area of Prince Edward Island (PMRA# 2518467); up to 10.4 and 11 µg/L in Ontario streams (PMRA# 2532563, 2523836); up to 7.77 µg/L in a creek located in a potato and vegetable growing region of Quebec (PMRA# 2035772); up to 9 µg/L in an urban storm water pond in South Carolina (PMRA# 2526151); up to 10 µg/L and 8 µg/L in a rivulet and pond near a rural golf course of Maryland, respectively (PMRA# 2538821); and up to 6.9 µg/L in a suburban river from Massachusetts (PMRA# 2526245).

These detections in various areas reflect the wide range of registered uses for imidacloprid. It is noted that urban and suburban use patterns of imidacloprid in Canada may not be as extensive as those in the United States.

Average concentrations of imidacloprid can provide an estimate of its presence in water over time. A longer term exposure estimate can be considered in the PMRA's chronic risk assessment for aquatic organisms. When average concentrations were not reported by the study authors, average concentrations of imidacloprid were calculated by the PMRA by assigning a value equal to half the limit of detection for samples that showed no detection. Results from studies with relatively high detection limits but low detection frequencies are more difficult to interpret. The non-detects could be due to factors such as the lack of sensitivity of the analytical method, the non-transport of the chemical from the site of application, or the lack of use of the chemical in the area studied. In cases where the observed detection frequency is low, an inflated average concentration may be calculated due to a relatively higher limit of detection as compared to studies with relatively lower limits of detection. As a result, the averages from studies with a low detection limit are considered more useful to estimate longer term exposure levels.

Results of a few relevant studies are presented below, and are briefly compared with the PMRA's most sensitive toxicity endpoint for chronic exposure of aquatic organisms. For imidacloprid, this endpoint is the median HC<sub>5</sub> value of 0.041 µg/L from the species sensitivity distribution for chronic effects on freshwater invertebrates. The HC<sub>5</sub> for chronic effects is the 5<sup>th</sup> percentile of the species sensitivity distribution for the EC<sub>50</sub> at 50% confidence intervals.

In 23 rivers, small creeks and drains located in agricultural regions of California, where mainly lettuce, cole crops and wine grapes are grown, imidacloprid levels in individual samples reported by Starner and Goh (PMRA# 2526148) were as high as 3.29 µg/L in 2010 and 2011. The overall detection frequency for imidacloprid in the 75 samples was 89% and the reporting limit was 0.05 µg/L. Mineau and Palmer (PMRA# 2526820) observed that based on the Starner and Goh (2012) data, sites sampled multiple times had levels of imidacloprid that were consistently high throughout the season. Of the 75 water samples analyzed, 67 (89%) had imidacloprid levels exceeding 0.041 µg/L. The PMRA-calculated average concentration for all 75 water samples was 0.66 µg/L; a value equal to half the reporting limit of 0.05 µg/L was assigned to non-detects in the calculation. It is noted that the uses of imidacloprid in California may not be representative of those in Canada.

The average concentration of imidacloprid in surface water bodies sampled in agricultural regions of Quebec between 2010 and 2014 was calculated by the PMRA to be 0.024 µg/L (PMRA# 2523837, 2544468, 2561884). For these data (355 water samples), the overall detection frequency was 68%, and the detection limit ranged from 0.001 to 0.002 µg/L. A total of 62 of the samples (17%) had levels of imidacloprid that were higher than the HC<sub>5</sub> of 0.041 µg/L for chronic effects to freshwater invertebrates.

The average concentration of imidacloprid in a creek located in a potato and vegetable growing area of Quebec was 1.26 µg/L in 2005 and 2006 (PMRA# 2035772). It should be noted that only seven samples were collected in this creek, but imidacloprid was detected in six of the seven (86%) samples at levels exceeding 0.041 µg/L.

An overall average imidacloprid concentration of 0.18 µg/L was estimated by the PMRA using data from Environment Canada for samples from several Ontario streams located in agricultural and urban areas as well as in a reference site removed from agricultural activities, (PMRA# 2526820, 2523839, 2532563). A total of 86% of the 470 water samples analyzed had detectable levels of imidacloprid. The detection limit was 0.00128 µg/L. A total of 24% of these samples had imidacloprid levels above 0.041 µg/L. Considering samples in only agricultural areas (excluding the reference site and urban areas and those for which the land use was unknown), imidacloprid was detected in 90% of 391 water samples, the average concentration was 0.22 µg/L, and 28% of the samples had imidacloprid levels above 0.041 µg/L.

In creeks, rivers and drains located in California, the average concentration of imidacloprid was estimated to be 0.81 µg/L in 2013 (PMRA# 2482494). A total of 84% of the 51 samples had imidacloprid levels above the PMRA's chronic HC<sub>5</sub> value of 0.041 µg/L for freshwater invertebrates. The overall detection frequency for these data was 84% and the detection limit was 0.05 µg/L. As noted above, the uses of imidacloprid in California may not be representative of those in Canada.

Maximum concentrations of imidacloprid-urea and imidacloprid-guanidine detected in surface water relevant for aquatic risk assessment purposes were 0.2 and 0.3 µg/L, respectively, from rivers and creeks in areas of intense agriculture in Quebec. Imidacloprid-olefin was not detected in surface water samples relevant for the purposes of an aquatic risk assessment.

#### *Estuarine or ocean water*

Very few retrospective monitoring data for imidacloprid in estuarine or ocean water from Canada or the US are available. Imidacloprid was detected in 2 of a total of 21 samples (10% detection) of estuarine or ocean water analyzed in the State of Florida, US in 2013 (PMRA# 2517041). The maximum concentration of imidacloprid detected was 0.018 µg/L. Monitoring data on transformation products of imidacloprid in estuarine or ocean water were not available. The monitoring data for imidacloprid and its transformation products are not robust enough for use in a risk assessment for marine/estuarine organisms.

#### *More detailed assessment of risk to freshwater invertebrates using robust Canadian monitoring data sets*

The freshwater invertebrate end-points for acute and chronic exposure are 0.36 µg/L (HC<sub>5</sub> of acute LC<sub>50s</sub>) and 0.041 µg/L (the HC<sub>5</sub> of chronic EC<sub>50s</sub>), respectively. The risks to freshwater invertebrates were evaluated in more detail using robust Canadian data sets from Ontario, Quebec and Saskatchewan.

In southwestern Ontario, the most exceedances of acute and chronic endpoints for freshwater invertebrates were associated with greenhouse and vegetable uses of imidacloprid (Table 3).



- *Greenhouse and vegetable uses areas*
  - Imidacloprid levels exceeded the acute endpoint for freshwater invertebrates in three areas associated with greenhouse and vegetable uses. In these three areas, the acute endpoint was exceeded between 3% (3/112) and 68% (27/38) of the time and the risk quotients ranged from 1.5 to 28.9.
  - Imidacloprid levels exceeded the chronic endpoint for freshwater invertebrates in four areas associated with greenhouse and vegetable uses. In these areas, the chronic endpoint was exceeded between 20% (2/10) and 100% (26/26 and 38/38) of the time depending on the area, and the risk quotients ranged from 0.7 to 34.6.
- *Row crops (mainly corn and soybeans)*
  - Imidacloprid levels did not exceed the acute endpoint and seldom exceeded (0-3%) the chronic endpoint for freshwater invertebrates in areas of use on row crops. No risk quotients exceeded the level of concern. Imidacloprid is not expected to pose a risk to freshwater invertebrates in these areas because it is not used extensively. This result is expected as imidacloprid is not typically used on corn and soybeans.

In Quebec, imidacloprid sampling from agriculture use areas of corn/soybean and potato were examined separately (Table 4).

- *Corn/soybean use areas*
  - Imidacloprid did not exceed the acute endpoint for freshwater invertebrates in any samples.
  - Imidacloprid exceeded the chronic endpoint for freshwater invertebrates in only 2 out of 165 samples (1% of samples). The risk quotient is below the level of concern based on the average concentration in water in these areas.
  - Imidacloprid is not expected to pose a risk to freshwater invertebrates in areas of corn/soybean use because it is not used extensively in these areas. This result is expected as imidacloprid is not typically used in this sector.
- *Potato and mixed vegetable/potato use areas*
  - Imidacloprid exceeded the acute endpoint for freshwater invertebrates in 1% of samples (2/141). The risk quotient based on maximum level detected is 21.6.
  - Imidacloprid exceeded the chronic endpoint for freshwater invertebrates in 45% of samples (64/141). The risk quotient based on overall average concentration in water in these areas was 2.7. These data encompass four waterbodies.
  - On a more site-specific basis in one stream in a mixed vegetable/potato growing area, the highest average concentration was 1.26 µg/L based on 7 samples. Six of the 7 samples (86%) exceeded the chronic endpoint for freshwater invertebrates. The risk quotient based on the average concentration at this site was 31. This was used in the initial monitoring data assessment for chronic exposure in Table 30 of Appendix IX.
  - In potato and mixed vegetable/potato growing areas, imidacloprid is expected to pose an acute and chronic risk for freshwater invertebrates based on exceedances of acute endpoints 1% of the time, and overall exceedances of chronic endpoints 45% of the time (86% of the time in one waterbody).

In Saskatchewan, imidacloprid was sampled from wetlands in agricultural areas, primarily of canola and cereals (683 samples) (Table 5). Use of imidacloprid in the prairies is primarily as a seed treatment and seeds for many prairie crops including canola tend to be treated with insecticides other than imidacloprid.

- Imidacloprid did not have any exceedance of the acute freshwater invertebrate endpoint.
- Imidacloprid had very few exceedances of the chronic freshwater invertebrate endpoint (0% - 10% in sampling between Spring 2012 and Spring 2014). This is expected as imidacloprid is not used extensively in this sector.

Despite these associations, the risks to aquatic invertebrates cannot be readily attributed to an application method (for example, seed treatment, foliar uses or soil applications). This is because all application methods may be used on crops in areas where imidacloprid is detected (vegetables and potato uses).

Imidacloprid occurrence, levels detected and exceedances of acute and chronic endpoints vary by waterbodies and areas. The variability could be due to differences in factors such as the types of crops/uses surrounding waterbodies, the percentage of various crops/uses within watersheds (i.e., the intensity of use) and specific waterbody/watershed characteristics.

#### *General findings related to the available monitoring data*

Monitoring data likely provide an underestimate of actual exposure, as sampling typically does not capture peak concentrations.

Non-detections can be difficult to interpret, particularly when the limit of detection is high, and when use information in the vicinity of sampling areas is not available. The non-detects could be due to factors such as the non-transport of the chemical from the site of application, the lack of use of the chemical in the area studied, or to the lack of sensitivity of the analytical method.

Robust Canadian freshwater monitoring data were available for areas of Ontario, Quebec and Saskatchewan. Monitoring data were typically scarce or not robust for other areas of Canada. However, in areas where imidacloprid is used but monitoring data are lacking, there is no reason to believe detection patterns would differ compared to those observed in areas where monitoring data are available.

The intensity of use in the watershed affects levels of imidacloprid in water; higher intensity of use (based on percentage of a crop in the watershed) typically results in higher levels in water.

The use areas/crops surrounding waterbodies sampled differ between data sets.

The multiple uses within some watersheds complicate the task of relating imidacloprid levels in water to a specific use.

**Table 1 Summary of available relevant surface water monitoring data for imidacloprid and its transformation products in Canada, for consideration in the aquatic risk assessment**

| Source reference                                                                                                                                                   | Sampling year | Location                                         | Water type    | Land use (crop; timing)                                              | LOD (µg/L)  | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------------------------------------|---------------|----------------------------------------------------------------------|-------------|---------------------------|--------------------------|-----------|-----------|-------------|
| <b>Imidacloprid</b>                                                                                                                                                |               |                                                  |               |                                                                      |             |                           |                          |           |           |             |
| Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, 2014 (PMRA# 2523837); Giroux, 2014 (PMRA# 2544468); Giroux, 2015 (PMRA# 2561884) | 2010-2014     | Quebec                                           | Surface water | Agricultural (corn, soybean, potato, apple orchards, mixed cultures) | 0.001-0.002 | 0.024                     | 0.31                     | 242       | 355       | 68          |
| Environment Canada, 2011 (PMRA# 2525751); Environment Canada, 2006 (PMRA# 1403269); Environment Canada, 2007 (PMRA# 2424839)                                       | 2003-2005     | New Brunswick, Prince Edward Island, Nova Scotia | Surface water | Agricultural                                                         | 0.1-0.3     | NR                        | NR                       | 2         | 187       | 1           |
| Environment Canada (PMRA# 1401896); Environment Canada (PMRA# 1401897)                                                                                             | 2000-2001     | Ontario                                          | Surface water | Urban                                                                | 0.25-2.5    | NR                        | <1.0                     | 2         | 194       | 1           |
| Environment Canada, 2006 (PMRA# 1403269)                                                                                                                           | 2003-2005     | Ontario                                          | Lakes         | NR                                                                   | NR          | ND                        | ND                       | 0         | 168       | 0           |
| Giroux and Fortin, 2010 (PMRA# 2035772)                                                                                                                            | 2005-2006     | Quebec                                           | Creek         | Agricultural (potato and vegetable)                                  | 0.001       | 1.26                      | 7.77                     | 7         | 7         | 100         |

| Source reference                                                                                                                                                   | Sampling year | Location                                                 | Water type                     | Land use (crop; timing)                                                                                 | LOD (µg/L) | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------|------------|---------------------------|--------------------------|-----------|-----------|-------------|
| Environment Canada, 2011 (as cited in Mineau and Palmer, 2013 (PMRA# 2526820)); Environment Canada, 2014 (PMRA# 2523839); Environment Canada, 2015 (PMRA# 2532563) | 2011-2014     | Ontario                                                  | Surface water (mainly streams) | Agriculture (field crops, vines and orchards, greenhouse, fruit), urban, pristine, residential, unknown | 0.00128    | 0.1813                    | 10.400                   | 402       | 470       | 86          |
| Government of PEI (PMRA# 2468268)                                                                                                                                  | 2009-2014     | Prince Edward Island                                     | Surface Water                  | Various                                                                                                 | 0.02       | NC                        | 0.20                     | 3         | 72        | 4           |
| Murphy <i>et al.</i> , 2006 (as cited in CCME, 2007 (PMRA# 2526803))                                                                                               | 2003-2005     | New Brunswick                                            | Agricultural streams           | Agricultural                                                                                            | 0.2        | NR                        | NR                       | NR        | NR        | 4           |
| PMRA# 2548876                                                                                                                                                      | 2014          | British Columbia, Manitoba, Ontario, Quebec, Nova Scotia | Ditch, stream, culvert         | Agricultural                                                                                            | 0.0011     | 0.0059                    | 0.0112                   | 1         | 13        | 8           |
| Main <i>et al.</i> , 2014 (PMRA# 2526133, 2612760)                                                                                                                 | 2012          | Saskatchewan                                             | Prairie wetlands               | Agriculture (barley, canola, oats, wheat, field pea, grasslands; pre-seeding)                           | 0.0011     | NC                        | 0.0303                   | 3         | 136       | 2           |
| Main <i>et al.</i> , 2014 (PMRA# 2526133, 2612760)                                                                                                                 | 2012          | Saskatchewan                                             | Prairie wetlands               | Agriculture (barley, canola, oats, wheat, field pea, grasslands; growing)                               | 0.0011     | NC                        | 0.256                    | 11        | 134       | 8           |



| Source reference                                                                                       | Sampling year | Location             | Water type                                                                | Land use (crop; timing)                                                       | LOD (µg/L) | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|--------------------------------------------------------------------------------------------------------|---------------|----------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------|---------------------------|--------------------------|-----------|-----------|-------------|
| Main <i>et al.</i> , 2014 (PMRA# 2526133, 2612760)                                                     | 2012          | Saskatchewan         | Prairie wetlands                                                          | Agriculture (barley, canola, oats, wheat, field pea, grasslands; at harvest)  | 0.0011     | ND                        | ND                       | 0         | 80        | 0           |
| Main <i>et al.</i> , 2014 (PMRA# 2526133, 2612760)                                                     | 2013          | Saskatchewan         | Prairie wetlands                                                          | Agriculture (barley, canola, oats, wheat, field pea, grasslands; pre-seeding) | 0.0011     | NC                        | 0.0048                   | 2         | 90        | 2           |
| Denning <i>et al.</i> , 2004 (PMRA# 2518467)                                                           | 2001-2002     | Prince Edward Island | Runoff                                                                    | Agricultural (potato)                                                         | 0.5        | NR                        | 11.9                     | 27        | 62        | 44          |
| Julien <i>et al.</i> , 1996 (PMRA# 2518490)                                                            | 1995          | Prince Edward Island | Runoff                                                                    | Agricultural (potato)                                                         | 0.003      | >0.1 - >0.5               | >0.5                     | NR        | NR        | NR          |
| Hewitt, 2006 (as cited in CCME, 2007 (PMRA# 2526803))                                                  | 2003-2005     | New Brunswick        | Runoff, streams                                                           | Agriculture (potato)                                                          | 0.2        | NR                        | 0.3                      | NR        | NR        | NR          |
| Ontario Ministry of the Environment and Ontario Ministry of Agriculture and Food, 2013 (PMRA# 2523836) | 2012-2013     | Ontario              | Streams                                                                   | NR                                                                            | 0.126      | NC                        | 11                       | 4         | 198       | 2           |
| Environment Canada, 2006 (PMRA# 1403269)                                                               | 2003-2005     | Ontario              | Streams, amphibian breeding sites, channels, Great Lakes Areas of Concern | NR                                                                            | NR         | ND                        | ND                       | 0         | 593       | 0           |

| Source reference                                              | Sampling year | Location          | Water type                                                           | Land use (crop; timing)                                                         | LOD (µg/L)   | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|---------------------------------------------------------------|---------------|-------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------|---------------------------|--------------------------|-----------|-----------|-------------|
| Byrtus <i>et al.</i> , 2002 (PMRA# 1311124)                   | 1999-2000     | Alberta           | Surface water (irrigation return flows and dry-land farming streams) | Agricultural                                                                    | 0.02-1       | ND                        | ND                       | 0         | 42        | 0           |
| PMRA# 2548877                                                 | 2013          | Ontario, Manitoba | Pond, creek, stream, culvert                                         | Agricultural                                                                    | NR           | NC                        | 0.066                    | 1         | 68        | 1           |
| PMRA# 2548877                                                 | 2014          | Ontario, Manitoba | Pond, creek, marsh,                                                  | Agricultural                                                                    | 0.0011       | 0.0018                    | 0.018                    | 7         | 23        | 30          |
| Schaafsma <i>et al.</i> , 2015 (PMRA# 2526184)                | 2013          | Ontario           | Ditches, field drainage outlets within and outside of corn field     | Agricultural (corn)                                                             | 0.01         | NC                        | 0.06                     | 3         | 30        | 10          |
| Xing <i>et al.</i> , 2013 (PMRA# 2526162)                     | 2003-2005     | New Brunswick     | Streams                                                              | Agricultural, urban, forested                                                   | 0.0066       | 0.46                      | NR                       | NR        | NR        | 7           |
| Main <i>et al.</i> , 2016 (PMRA# 2572395, 2612761)            | 2014          | Saskatchewan      | Prairie wetlands                                                     | Agriculture (canola, oats, prior to seeding)                                    | 0.0023       | ND                        | ND                       | 0         | 76        | 0           |
| Main <i>et al.</i> , 2015 (PMRA#2608629, 2612762)             | 2013          | Saskatchewan      | Prairie wetlands                                                     | Agriculture (barley, canola, oats, flax, wheat, field pea, grasslands; growing) | 0.0011       | NC                        | 0.196                    | 17        | 145       | 12          |
| <b>Imidacloprid-urea</b>                                      |               |                   |                                                                      |                                                                                 |              |                           |                          |           |           |             |
| Ministère du Développement durable, de l'Environnement, de la | 2010-2014     | Quebec            | Surface water                                                        | Agricultural (corn, soybean, potato, apple orchards,                            | 0.0009-0.016 | 0.003                     | 0.2                      | 62        | 355       | 17          |

| Source reference                                                                                                                                                   | Sampling year | Location | Water type    | Land use (crop; timing)                                              | LOD (µg/L)    | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------|---------------|----------------------------------------------------------------------|---------------|---------------------------|--------------------------|-----------|-----------|-------------|
| Faune et des Parcs, 2014 (PMRA# 2523837); Giroux, 2014 (PMRA# 2544468); Giroux, 2015 (PMRA# 2561884)                                                               |               |          |               | mixed cultures)                                                      |               |                           |                          |           |           |             |
| Giroux and Fortin, 2010 (PMRA# 2035772)                                                                                                                            | 2005-2006     | Quebec   | Creek         | Agricultural (potato and vegetable)                                  | 0.0009        | 0.012                     | 0.054                    | 3         | 7         | 43          |
| <b>Imidacloprid-guanidine</b>                                                                                                                                      |               |          |               |                                                                      |               |                           |                          |           |           |             |
| Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, 2014 (PMRA# 2523837); Giroux, 2014 (PMRA# 2544468); Giroux, 2015 (PMRA# 2561884) | 2010-2014     | Quebec   | Surface water | Agricultural (corn, soybean, potato, apple orchards, mixed cultures) | 0.0008-0.0018 | 0.002                     | 0.033                    | 51        | 355       | 14          |
| Giroux and Fortin, 2010 (PMRA# 2035772)                                                                                                                            | 2005-2006     | Quebec   | Creek         | Agricultural (potato and vegetable)                                  | 0.0008        | 0.095                     | 0.3                      | 7         | 7         | 100         |
| <b>Imidacloprid-olefin</b>                                                                                                                                         |               |          |               |                                                                      |               |                           |                          |           |           |             |
| Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, 2014 (PMRA# 2523837); Giroux, 2014 (PMRA# 2544468); Giroux, 2015                 | 2010-2014     | Quebec   | Surface water | Agricultural (corn, soybean, potato, apple orchards, mixed cultures) | 0.0007-0.0014 | ND                        | ND                       | 0         | 355       | 0           |

| Source reference                        | Sampling year | Location | Water type | Land use (crop; timing)             | LOD (µg/L) | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|-----------------------------------------|---------------|----------|------------|-------------------------------------|------------|---------------------------|--------------------------|-----------|-----------|-------------|
| (PMRA# 2561884)                         |               |          |            |                                     |            |                           |                          |           |           |             |
| Giroux and Fortin, 2010 (PMRA# 2035772) | 2005-2006     | Quebec   | Creek      | Agricultural (potato and vegetable) | 0.0007     | ND                        | ND                       | 0         | 7         | 0           |

**Table 2 Summary of available relevant surface water monitoring data for imidacloprid in the United States, for consideration in the aquatic risk assessment**

| Source reference                                                                     | Sampling year | Location                                                                        | Water type    | Land use (crop; timing)      | LOD (µg/L)  | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|--------------------------------------------------------------------------------------|---------------|---------------------------------------------------------------------------------|---------------|------------------------------|-------------|---------------------------|--------------------------|-----------|-----------|-------------|
| Choquette and Kroening, 2009 (PMRA# 2526164)                                         | 2003-2005     | Florida, US                                                                     | Lakes         | Agricultural (citrus crops)  | NR          | ND                        | 0.016                    | 1         | 28        | 4           |
| Hladik <i>et al.</i> , 2014 (PMRA# 2526141); Hladik and Kolpin, 2015 (PMRA# 2559713) | 2013-2014     | Iowa, US                                                                        | Rivers        | Agricultural (corn, soybean) | 0.002       | 0.0046                    | 0.0427                   | 22        | 83        | 27          |
| Wijnja <i>et al.</i> , 2014 (PMRA# 2526245)                                          | 2009-2010     | Massachusetts, US                                                               | Rivers        | Suburban                     | 0.02        | NR                        | 6.9                      | 18        | 118       | 15          |
| Ensminger <i>et al.</i> , 2013 (PMRA# 2526150)                                       | 2008-2011     | California, US                                                                  | Surface water | Urban                        | NR          | NR                        | 0.67                     | 23        | 45        | 51          |
| California DPR, 2014 (PMRA# 2517034)                                                 | 2000-2012     | California, US                                                                  | Surface water | Various                      | 0.0068-1.06 | 0.230                     | 3.29                     | 85        | 238       | 36          |
| Pfeuffer and Matson, 2001 (as cited in Fossen, 2006 (PMRA# 2526165))                 | 2001          | Florida, US                                                                     | Surface water | Agricultural                 | NR          | ND                        | 1                        | NR        | NR        | 3           |
| Smith, 2011 (PMRA# 2526832)                                                          | 2007-2008     | Massachusetts, US                                                               | Surface water | Agricultural                 | 0.06        | 0.0600                    | 1.21                     | 23        | 80        | 29          |
| USEPA, 2015 (PMRA# 2517041)                                                          | 2001-2014     | North Dakota, Minnesota, Florida, Colorado, Utah, Arizona, Wyoming, California, | Surface water | Various                      | 0.0018-0.05 | 0.016                     | 1.6                      | 142       | 1633      | 9           |



| Source reference                                                                                                                                                                                                                                                                       | Sampling year | Location              | Water type                              | Land use (crop; timing)                                                   | LOD (µg/L)   | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------|-----------------------------------------|---------------------------------------------------------------------------|--------------|---------------------------|--------------------------|-----------|-----------|-------------|
|                                                                                                                                                                                                                                                                                        |               | Arkansas, Montana, US |                                         |                                                                           |              |                           |                          |           |           |             |
| USGS, 2015 (PMRA# 2517040)                                                                                                                                                                                                                                                             | 1999-2013     | US                    | Surface water                           | Various                                                                   | 0.0049-0.5   | 0.042                     | 1.3178                   | 208       | 3029      | 7           |
| Fossen, 2006 (PMRA# 2526165)                                                                                                                                                                                                                                                           | NR            | California, US        | Surface water                           | Agricultural                                                              | NR           | ND                        | ND                       | NR        | NR        | NR          |
| USDA, 2006 (PMRA# 1852616); USDA, 2006 (PMRA# 1852618); USDA, 2007 (PMRA# 1852619); USDA, 2008 (PMRA# 1774484); USDA, 2009 (PMRA# 1852614); USDA, 2011 (PMRA# 2312776); USDA, 2012 (PMRA# 2312778); USDA, 2013 (PMRA# 2312780); USDA, 2014 (PMRA# 2505827); USDA, 2014 (PMRA# 2505828) | 2004-2013     | US                    | Untreated surface water                 | Various                                                                   | 0.0015-0.042 | NC                        | 0.202                    | 244       | 2516      | 10          |
| Deng, 2014 (PMRA# 2482494)                                                                                                                                                                                                                                                             | 2013          | California, US        | Creeks, rivers, ponds, drainage ditches | Agricultural                                                              | 0.05         | 0.812                     | 6.8                      | 43        | 51        | 84          |
| Stamer and Goh, 2012 (PMRA# 2526148)                                                                                                                                                                                                                                                   | 2010-2011     | California, US        | Rivers, creeks, drains                  | Agricultural (primarily lettuce, with broccoli, cauliflower, wine grapes) | 0.05         | 0.66                      | 3.29                     | 67        | 75        | 89          |
| Johnson and Pettis, 2014 (PMRA# 2538821)                                                                                                                                                                                                                                               | 2010          | Maryland, US          | Rivulets, ponds, drainage ditches       | Suburban                                                                  | 0.07         | 1.002                     | 10                       | 2         | 19        | 11          |
| Johnson and Pettis, 2014 (PMRA# 2538821)                                                                                                                                                                                                                                               | 2010          | Maryland, US          | Rivulets, ponds, farm runoff            | Rural                                                                     | 0.07         | 1.33                      | 25                       | 2         | 34        | 6           |

| Source reference                               | Sampling year | Location                                        | Water type              | Land use (crop; timing)                           | LOD (µg/L) | Mean concentration (µg/L) | Max concentration (µg/L) | N detects | N samples | % detection |
|------------------------------------------------|---------------|-------------------------------------------------|-------------------------|---------------------------------------------------|------------|---------------------------|--------------------------|-----------|-----------|-------------|
|                                                |               |                                                 | stream, irrigation pipe |                                                   |            |                           |                          |           |           |             |
| DeLorenzo <i>et al.</i> , 2012 (PMRA# 2526151) | 2006-2007     | South Carolina, US                              | Stormwater ponds        | Urban                                             | 0.3        | NR                        | 9                        | NR        | NR        | 7.1-10      |
| Churchel <i>et al.</i> , 2011 (PMRA# 2526161)  | 2005-2007     | Georgia and North Carolina, US                  | Streams                 | Forest                                            | 0.6        | <1.0                      | NR                       | NR        | NR        | NR          |
| Phillips and Bode, 2004 (PMRA# 2526163)        | 2000-2001     | New York, US                                    | Streams                 | Forest (70%), Urban (24%), Agricultural (6%)      | 0.106      | NR                        | 0.13                     | NR        | NR        | 40          |
| Smalling <i>et al.</i> , 2015 (PMRA# 2526244)  | 2012-2013     | Iowa, US                                        | Wetlands                | Agricultural (mainly corn and soybean)            | 0.001-0.01 | NR                        | 0.007                    | 2         | 33        | 6           |
| Phillips and Bode, 2004 (PMRA# 2526163)        | 2000-2001     | New York, US                                    | Streams                 | Forest (80%), Urban (13%), Agricultural (6%)      | 0.106      | NR                        | ND                       | 0         | NR        | 0           |
| USEPA, 2015 (PMRA# 2517041)                    | 2013          | Florida, US                                     | Ocean/estuarine water   | Various                                           | 0.002-0.05 | 0.002                     | 0.018                    | 2         | 21        | 10          |
| Hladik and Calhoun, 2012 (PMRA# 2526153)       | 2011-2012     | Georgia, US                                     | Streams                 | Forest (urban and agricultural)                   | 0.0049     | NR                        | 0.035                    | 17        | 23        | 74          |
| Hladik and Kolpin, 2015 (PMRA# 2559713)        | 2011-2014     | Various locations across the US and Puerto Rico | Rivers, streams, creeks | Agricultural and urban                            | 0.002      | 0.01                      | 0.143                    | 91        | 140       | 65          |
| Weston <i>et al.</i> , 2015 (PMRA# 2566514)    | 2014          | California, US                                  | Creeks                  | Urban, agricultural, mixed urban and agricultural | 0.01       | 0.26                      | 1.462                    | 8         | 10        | 80          |
| Benton <i>et al.</i> , 2016 (PMRA# 2620535)    | 2012-2013     | Tennessee, North Carolina, US                   | Streams                 | Forest                                            | 0.02       | 0.03                      | 0.379                    | 7         | 30        | 23          |

**Table 3 Comparison of imidacloprid monitoring data in waterbodies from agricultural areas of southwestern Ontario with toxicity endpoints**

|                                                                        | Overall   | Fruit, greenhouse, residential | row crop, or row crop, fruit | Row crop, potato, sod | Row crop, vegetable, greenhouse | Row crop, vegetable, tobacco | Vegetable | Vegetable, greenhouse |
|------------------------------------------------------------------------|-----------|--------------------------------|------------------------------|-----------------------|---------------------------------|------------------------------|-----------|-----------------------|
| N samples                                                              | 391       | 112                            | 140                          | 48                    | 26                              | 14                           | 10        | 38                    |
| Maximum (µg/L)                                                         | 10.4      | 0.486                          | 0.076                        | 0.028                 | 4.03                            | 0.005                        | 0.097     | 10.4                  |
| Average (µg/L)                                                         | 0.217     | 0.051                          | 0.006                        | 0.004                 | 0.913                           | 0.003                        | 0.027     | 1.419                 |
| N detects (% of samples) exceeding the acute endpoint of 0.36 µg/L     | 44 (11%)  | 3 (3%)                         | 0 (0%)                       | 0 (0%)                | 15 (58%)                        | 0 (0%)                       | 0 (0%)    | 26 (68%)              |
| RQ for acute exposure using 0.36 µg/L and the maximum detection        | 28.9      | 1.4                            | 0.2                          | 0.08                  | 11.2                            | 0.01                         | 0.3       | 28.9                  |
| N detects (% of samples) exceeding the chronic endpoint of 0.041 µg/L  | 111 (28%) | 41 (37%)                       | 4 (3%)                       | 0 (0%)                | 26 (100%)                       | 0 (0%)                       | 2 (20%)   | 38 (100%)             |
| RQ for chronic exposure using 0.041 µg/L and the average concentration | 5.3       | 1.3                            | 0.2                          | 0.1                   | 22.3                            | 0.06                         | 0.7       | 34.6                  |

**Table 4 Comparison of imidacloprid monitoring data in Quebec potato/vegetable and corn, soybean growing areas with toxicity endpoints**

|                                                                    | Overall | Corn, soybean | Potato and mixed vegetable/potato |
|--------------------------------------------------------------------|---------|---------------|-----------------------------------|
| N samples                                                          | 306     | 165           | 141                               |
| Maximum (µg/L)                                                     | 7.77    | 0.11          | 7.77                              |
| Average (µg/L)                                                     | 0.054   | 0.004         | 0.112                             |
| N detects (% of samples) exceeding the acute endpoint of 0.36 µg/L | 2 (<1%) | 0 (0%)        | 2 (1%)                            |

|                                                                        | Overall  | Corn,<br>soybean | Potato and mixed<br>vegetable/potato |
|------------------------------------------------------------------------|----------|------------------|--------------------------------------|
| RQ for acute exposure using 0.36 µg/L and the maximum detection        | 21.6     | 0.3              | 21.6                                 |
| N detects (% of samples) exceeding the chronic endpoint of 0.041 µg/L  | 66 (22%) | 2 (1%)           | 64 (45%)                             |
| RQ for chronic exposure using 0.041 µg/L and the average concentration | 1.3      | 0.1              | 2.7                                  |

**Table 5 Comparison of imidacloprid monitoring data in Saskatchewan wetlands with toxicity endpoints**

|                                                                           | Overall                                                                                       | Spring<br>2012 | Summer 2012 | Fall 2012 | Spring<br>2013 | Summer 2013 | Spring 2014 |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------|-------------|-----------|----------------|-------------|-------------|
| N samples                                                                 | 683                                                                                           | 138            | 134         | 80        | 90             | 166         | 75          |
| Maximum (µg/L)                                                            | 0.256                                                                                         | 0.03           | 0.256       | 0.001     | 0.005          | 0.196       | 0.001       |
| Average (µg/L)                                                            | The sampling regime did not allow for a longer term exposure concentration within a waterbody |                |             |           |                |             |             |
| N detects (% of samples) exceeding the acute endpoint of 0.36 µg/L        | 0 (0%)                                                                                        | 0 (0%)         | 0 (0%)      | 0 (0%)    | 0 (0%)         | 0 (0%)      | 0 (0%)      |
| RQ for acute exposure using 0.36 µg/L and the maximum detection           | 0.7                                                                                           | 0.08           | 0.7         | 0.002     | 0.01           | 0.5         | 0.005       |
| N detects (% of samples) exceeding the chronic endpoint of 0.041 µg/L     | 13 (2%)                                                                                       | 4 (3%)         | 13 (10%)    | 0 (0%)    | 0 (0%)         | 9 (5%)      | 0 (0%)      |
| RQ for chronic exposure using 0.041 µg/L and the single highest detection | 6.3                                                                                           | 0.7            | 6.3         | 0.01      | 0.1            | 4.8         | 0.01        |



## Appendix XI      SSD Analysis

### Summary of SSD analysis for foliar application uses of imidacloprid insecticide

The toxicity data analysis involves the overview of the available endpoints and the determination of a species sensitivity distribution (SSD) where possible. For data sets where an SSD cannot be determined, the most sensitive endpoint in each taxonomic group and category is identified. The critical value or threshold concentration derived from an SSD is the  $HC_5$ . The  $HC_5$  is an EEC which theoretically provides "protection" to 95% of species. The actual level of protection varies with the endpoint used in the assessment (for example,  $LC_{50}$  vs. NOEC) and the variability of the data and the effect it has on the fraction of species affected.

The software program ETX2 was used to generate the SSDs with a log-logistic equation for each of the various taxonomic groups. For this assessment, the median  $HC_5$  values are reported for SSDs along with the associated confidence limits. The variability in the data sets is indicated by the upper and lower bound  $HC_5$  estimates and also the confidence limit of the fraction of species affected (FA), which indicates the minimum and maximum percent of species that could be affected when exposed to the  $HC_5$  concentration.

The treatment of toxicity data allows for consistent quantitative comparisons and predictions and includes consistent exposure concentration units, comparability of measurement endpoints, duration of exposure and other factors. Biological and statistical considerations are used in data handling in order to ensure that the most representative and appropriate results are derived for each taxonomic group while maintaining consistency.

SSDs were determined for foliar application uses of imidacloprid insecticide for the following three taxonomic groups as data were limited for other taxa (results are reported in Table 1):

- Freshwater organisms: invertebrates, acute and chronic
- Marine organisms: invertebrates, acute
- Terrestrial organisms: birds, acute

All toxicity values were based on studies with the technical grade active ingredient or an end-use product, and concentrations of the active were of consistent units and expressed as appropriate (for example,  $\mu\text{g a.i./L}$  or  $\text{mg a.i./kg bw/d}$ ).

The most sensitive aquatic endpoint is the chronic  $HC_5$  value of  $0.041 \mu\text{g a.i./L}$  for freshwater invertebrates, while the acute  $HC_5$  value was determined to be  $0.36 \mu\text{g a.i./L}$ .

Marine invertebrates are approximately one order of magnitude less sensitive, having an acute  $HC_5$  of  $1.37 \mu\text{g a.i./L}$ . The avian acute  $HD_5$  is  $8.07 \text{ mg a.i./kg bw}$ .

**Table 1 Species sensitivity distribution (SSD) analysis presenting HC<sub>5</sub><sup>1</sup> values for foliar application of imidacloprid insecticide.**

| Exposure | Test material                                                              | Endpoint type                      | Freshwater inverts<br>(µg a.i./L)                                                                               | Marine inverts<br>(µg a.i./L)                                                                                      | Birds<br>(mg a.i./kg bw)                                                                                 |
|----------|----------------------------------------------------------------------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Acute    | technical grade active ingredient or end-use products. Expressed as a.i./L | EC <sub>50</sub> /LC <sub>50</sub> | HC <sub>5</sub> : 0.36<br>Species count: 32 (48 – 96hr)<br>LLHC5: 0.075<br>ULHC5: 1.1<br>LLFA: 1.7<br>ULFA: 9.7 | HC <sub>5</sub> : 1.37<br>Species count: 6 (24-96 hr)<br>LLHC5: 0.00093<br>ULHC5: 35.9<br>LLFA: 0.25<br>ULFA: 27.7 | HD <sub>5</sub> : 8.07<br>Species count: 7 (7-14d)<br>LLHC5: 1.4<br>ULHC5: 18.9<br>LLFA: 0.3<br>ULFA: 25 |
| Chronic  |                                                                            | EC <sub>50</sub>                   | HC <sub>5</sub> : 0.041<br>Species count: 10 (21-28d)<br>LLHC5: 0.0016<br>ULHC5: 0.266<br>LLFA: 0.7<br>ULFA: 19 | NA                                                                                                                 | NA                                                                                                       |

<sup>1</sup>Hazardous concentration (or dose) to 5% of species. LLHC5 = lower level HC5, ULHC5 = upper level HC5, LLFA = lower level fraction affected; ULFA = upper level fraction affected.

**Notes on data set:**

- **Freshwater acute invertebrate data:** EC<sub>50</sub> values were used in SSD when they were available otherwise LC<sub>50</sub> values were used.
- **Freshwater chronic invertebrates:** EC<sub>50</sub> values were used because they were shown to be chronic exposures, while most of the NOEC values were found to be of an unacceptable exposure duration or were not a standard laboratory study.
- **Marine acute invertebrates:** One of the study endpoint values was reported as "> 23.3 mg a.i./L". This study was not a limit test and it indicated no adverse effect on shell growth of oysters, i.e., a 50% reduction was not observed at the highest concentration. This is considered to be a valid endpoint.
- **Formulation type:** Toxicity data were combined for all formulation and technical grade active ingredient tests and values are expressed as a.i./unit equivalent.
- **Multiple toxicity values for the same species:** Where multiple toxicity values for the same species were available, the species' geometric mean was calculated and used in the SSD.



## Appendix XII Toxic Substances Management Policy

**Table 1 Toxic Substances Management Policy Considerations - Comparison to TSMP Track 1 Criteria**

| TSMP Track 1 Criteria                                                                                | TSMP Track 1 Criterion value       |                                                              | Imidacloprid<br>Are criteria met?                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Toxic or toxic equivalent according to the <i>Canadian Environmental Protection Act</i> <sup>1</sup> | Yes                                |                                                              | Yes                                                                                                                                                                                                                                                                            |
| Predominantly anthropogenic <sup>2</sup>                                                             | Yes                                |                                                              | Yes                                                                                                                                                                                                                                                                            |
| Persistence <sup>3</sup> :                                                                           | Soil                               | Half-life<br>≥ 182 days                                      | Yes: 157 - 973 days                                                                                                                                                                                                                                                            |
|                                                                                                      | Water                              | Half-life<br>≥ 182 days                                      | No: < 5 days (sunlight)                                                                                                                                                                                                                                                        |
|                                                                                                      | Whole system<br>(Water + Sediment) | Half-life<br>≥ 365 days                                      | No: 30 – 159                                                                                                                                                                                                                                                                   |
|                                                                                                      | Air                                | Half-life ≥ 2 days or<br>evidence of long range<br>transport | Half-life or volatilization is not an important route of dissipation and long-range atmospheric transport is unlikely to occur based on the vapour pressure ( $1.5 \times 10^{-9}$ mm Hg at 20°C) and Henry's law constant ( $9.89 \times 10^{-13}$ atm m <sup>3</sup> /mole). |
| Bioaccumulation <sup>4</sup>                                                                         | Log <i>K</i> <sub>OW</sub> ≥ 5     |                                                              | No: 0.57                                                                                                                                                                                                                                                                       |
|                                                                                                      | BCF ≥ 5000                         |                                                              | 0.97 – 3.7                                                                                                                                                                                                                                                                     |
|                                                                                                      | BAF ≥ 5000                         |                                                              | Not available                                                                                                                                                                                                                                                                  |
| Is the chemical a TSMP Track 1 substance (all four criteria must be met)?                            |                                    |                                                              | No, does not meet all TSMP Track 1 criteria.                                                                                                                                                                                                                                   |

All pesticides will be considered toxic or toxic equivalent for the purpose of initially assessing a pesticide against the TSMP criteria. Assessment of the CEPA toxicity criteria may be refined if required (i.e., all other TSMP criteria are met).

<sup>2</sup> The policy considers a substance "predominantly anthropogenic" if, based on expert judgment, its concentration in the environment medium is largely due to human activity, rather than to natural sources or releases.

<sup>3</sup> If the pesticide and/or the transformation product(s) meet one persistence criterion identified for one media (soil, water, sediment or air) then the criterion for persistence is considered to be met.

<sup>4</sup> The log  $K_{OW}$  and/or BCF and/or BAF are preferred over log  $K_{OW}$ .





## **Appendix XIII    Proposed Label Amendments for Products Containing Imidacloprid**

The label amendments presented below do not include all label requirements for individual end-use products, such as first aid statements, disposal statements, precautionary statements and supplementary protective equipment. Additional information on labels of currently registered products should not be removed unless it contradicts the label statements given below.

Note: The following information is divided according to product type.

### **1. For products with uses that have been proposed for continued registration, the following label amendments are required:**

#### **1.1 Label Amendments for Technical Class Products Containing Imidacloprid**

The hazard statement on the primary display panel of the technical product for Registration Number 28936 must be revised from WARNING – POISON to DANGER – POISON.

The following statement is to be added to the “Environmental Hazards” section of the Imidacloprid Technical Insecticide label:

“TOXIC to aquatic organisms, beneficial arthropods, and birds and small mammals.”

The following statement is required under the “Precautions” Section of the imidacloprid Technical Insecticide label:

“DO NOT discharge effluent containing this product into sewer systems, lakes, streams, ponds, estuaries, oceans or other waters”

### **2. Following consultation on the proposed decision, if products with uses that have been proposed for cancellation are acceptable for continued registration, the following label amendments will be required where applicable:**

#### **2.1 Commercial Class Products Containing Imidacloprid**

##### **2.1.1 Change in packaging**

###### **Commercial Seed Treatment for Canola and Mustard:**

Water soluble packaging is required for products formulated as a wettable powder to be used for seed treatment of canola and mustard.

##### **2.1.2 Personal Protective Equipment**

Label statements must be amended (or added) to include the following directions to the appropriate labels, unless the current label mitigation is more restrictive:

**Commercial Seed Treatment for Canola and Mustard:**

"Use closed transfer for commercial seed treatment (in facilities or with mobile treaters). Closed transfer includes closed mixing, loading, calibrating and closed treatment equipment. No open transfer is permitted. Treaters and handlers (for example, baggers, sewers, stackers) must wear chemical-resistant gloves, and coveralls over long-sleeved shirt, long pants, chemical-resistant footwear, and socks."

"When cleaning seed treatment equipment, workers must wear chemical-resistant coveralls over long-sleeved shirt, long pants, chemical-resistant footwear, socks, chemical-resistant gloves and a respirator with a NIOSH-Approved organic-vapour-removing cartridge with a prefilter approved for pesticides OR a NIOSH-Approved canister approved for pesticide."

**Commercial Seed Treatment for All Seed Types:**

"When cleaning seed treatment equipment, workers must wear chemical-resistant coveralls over long-sleeved shirt, long pants, chemical-resistant footwear, socks, chemical-resistant gloves and a respirator with a NIOSH-Approved organic-vapour-removing cartridge with a prefilter approved for pesticides OR a NIOSH-Approved canister approved for pesticides."

**Planting of commercially treated seed:**

Treated seed bags must be labelled or tagged with the following instructions for workers planting treated seed.

"Closed cabs must be used for planting commercially treated and bagged seeds."

"Do not plant treated seeds by hand"

**All other seed treatment and potato seed piece uses:**

"When treating seeds, handling and planting treated seeds, workers must wear a long-sleeved shirt, long pants, shoes plus socks, and chemical-resistant gloves. "

**Planting of all treated seed:**

"Do not plant treated seed by hand."

**2.1.3 Restricted-Entry Intervals:**

The following label wording must be added to commercial end-use products, if not already specified:

"The restricted-entry interval is 12 hours after application for all agricultural uses."

The following label wording must be added to commercial end-use products applied as a liquid to turf in residential areas and golf courses, if not already specified:

"Do not enter or allow others (for example: children, pets) to enter treated areas until spray has dried."

#### 2.1.4 Use Precautions

The following label wording must be added to commercial end-use products:

"Apply only when the potential for drift to areas of human habitation or areas of human activity (excluding golf courses) such as houses, cottages, schools and recreational areas, including parks, school grounds, and playing fields, is minimal, taking into consideration wind speed, wind direction, temperature inversions, application equipment and sprayer settings."

#### 2.1.5 ENVIRONMENTAL PRECAUTIONS/HAZARDS

The following label wording must be added to commercial end-use products for foliar applications, if not already specified:

"TOXIC to aquatic organisms. Observe buffer zones specified under DIRECTIONS FOR USE."

"TOXIC to birds."

"To reduce runoff from treated areas into aquatic habitats avoid application to areas with a moderate to steep slope, compacted soil, or clay."

"Avoid application when heavy rain is forecast."

"Contamination of aquatic areas as a result of runoff may be reduced by including a vegetative strip between the treated area and the edge of the water body."

"The use of this chemical may result in contamination of groundwater particularly in areas where soils are permeable (for example, sandy soil) and/or the depth to the water table is shallow."

"Toxic to certain beneficial insects. May impact predatory and parasitic arthropod species used in IPM programs within the treatment area. Minimize spray drift to reduce harmful effects on beneficial insects in habitats next to the application site such as hedgerows and woodland."

The following label wording must be added to commercial end-use products for seed treatments, if not already specified:

"Treated seed is toxic to birds and small wild mammals. Any spilled or exposed seeds must be incorporated into the soil or otherwise cleaned-up from the soil surface."



The following label wording must be added to commercial end-use products for use in greenhouses, if not already specified:

“Toxic to bees and other beneficial insects. May harm bees and other beneficial insects used in greenhouse production. Avoid application when bees or other beneficial insects are actively foraging in the treatment area.”

“DO NOT allow effluent or runoff from greenhouses containing this product to enter lakes, streams, ponds or other waters.”

#### 2.1.6 DIRECTIONS FOR USE

For commercial products with foliar applications to crops that may also be grown in greenhouses (for example: cucumber, tomato) add:

“Not for foliar use in Greenhouse.”

The following statements are to be added after the MIXING INSTRUCTIONS for commercial end-use products with foliar applications:

As this pesticide is not registered for the control of pests in aquatic systems, **DO NOT** use to control aquatic pests.

**DO NOT** contaminate irrigation or drinking water supplies or aquatic habitats by cleaning of equipment or disposal of wastes.

Field sprayer application: **DO NOT** apply during periods of dead calm. Avoid application of this product when winds are gusty. **DO NOT** apply with spray droplets smaller than the American Society of Agricultural Engineers (ASAE S572.1) fine classification. Boom height must be 60 cm or less above the crop or ground.

Airblast application: **DO NOT** apply during periods of dead calm. Avoid application of this product when winds are gusty. **DO NOT** direct spray above plants to be treated. Turn off outward pointing nozzles at row ends and outer rows. **DO NOT** apply when wind speed is greater than 16 km/h at the application site as measured outside of the treatment area on the upwind side.

The following statement is to be added to all commercial end-use products except Reg. No. 29611:

“**DO NOT** apply by air.”

The following statement is to be added to the label of Reg. No. 29611:

“Aerial application: **DO NOT** apply during periods of dead calm. Avoid application of this product when winds are gusty. **DO NOT** apply when wind speed is greater than 16 km/h at flying height at the site of application. **DO NOT** apply with spray droplets smaller than the American Society of Agricultural Engineers (ASAE S572.1) fine classification. To reduce drift caused by turbulent wingtip vortices, the nozzle distribution along the spray boom length **MUST NOT** exceed 65% of the wing- or rotorspan.”

**Buffer zones:**

“Use of the following spray methods or equipment **DO NOT** require a buffer zone: hand-held or backpack sprayer and spot treatment.”

“The buffer zones specified in the table below are required between the point of direct application and the closest downwind edge of sensitive freshwater habitats (such as lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs and wetlands) and estuarine/marine habitats.”

| Method of application | Crop                                                                |                    | Buffer Zones (metres) Required for the Protection of: |                  |                                      |                  |
|-----------------------|---------------------------------------------------------------------|--------------------|-------------------------------------------------------|------------------|--------------------------------------|------------------|
|                       |                                                                     |                    | Freshwater Habitat of Depths:                         |                  | Estuarine/Marine Habitats of Depths: |                  |
|                       |                                                                     |                    | Less than 1 m                                         | Greater than 1 m | Less than 1 m                        | Greater than 1 m |
| Field sprayer         | Lowbush blueberry, 13G                                              |                    | 25                                                    | 15               | 5                                    | 3                |
|                       | Artichoke, tobacco, peanut, Crop Groups 1B, 1D, 2, 4A, 5, 6, 8, 19A |                    | 30                                                    | 15               | 5                                    | 3                |
|                       | Hops                                                                |                    | 30                                                    | 15               | 5                                    | 4                |
|                       | Potato, tomato, Crop Sub-group 5A                                   |                    | 40                                                    | 20               | 10                                   | 4                |
|                       | Turf                                                                |                    | 65                                                    | 30               | 15                                   | 5                |
| Airblast              | Crop Group 11                                                       | Late growth stage  | 40                                                    | 30               | 20                                   | 10               |
|                       |                                                                     | Early growth stage | 45                                                    | 35               | 20                                   | 15               |
|                       | Highbush blueberry                                                  | Late growth stage  | 35                                                    | 25               | 15                                   | 5                |
|                       |                                                                     | Early growth stage | 45                                                    | 35               | 25                                   | 15               |
|                       | Hops, Crop Groups 12, 13F, 14                                       | Late growth stage  | 35                                                    | 25               | 15                                   | 5                |

|         |                               |                    |     |     |     |    |
|---------|-------------------------------|--------------------|-----|-----|-----|----|
|         | Crop Group 13A                | Early growth stage | 45  | 40  | 25  | 15 |
|         |                               | Late growth stage  | 35  | 30  | 15  | 10 |
|         | Crop Group 13B                | Early growth stage | 50  | 40  | 30  | 20 |
|         |                               | Late growth stage  | 40  | 30  | 20  | 10 |
|         | Cherries (sweet, sour, choke) | Early growth stage | 55  | 45  | 35  | 25 |
|         |                               | Late growth stage  | 45  | 35  | 25  | 15 |
|         | Raspberry                     | Early growth stage | 55  | 45  | 35  | 25 |
|         |                               | Late growth stage  | 45  | 40  | 25  | 20 |
| Aerial* | Potato, soybean               | Fixed wing         | 800 | 800 | 200 | 55 |
|         |                               | Rotary wing        | 800 | 600 | 175 | 40 |

\* For PCP Reg. No. 29611 only

“For tank mixes, consult the labels of the tank-mix partners and observe the largest (most restrictive) buffer zone of the products involved in the tank mixture and apply using the coarsest spray (ASAE) category indicated on the labels for those tank mix partners.”

“The buffer zones for this product can be modified based on weather conditions and spray equipment configuration by accessing the Buffer Zone Calculator on the Pest Management Regulatory Agency web site. Buffer zones of 800 m (aerial sprayer) CANNOT be modified.”

The following label wording must be added to commercial end-use products for use in greenhouses, if not already specified:

“To protect pollinators, follow the instructions regarding bees in the Environmental Precautions section.”

## List of References

### A. Registrant Submitted Studies/Information

#### A.1.0 Chemistry Assessment

| PMRA Document Number | Reference                                                                                                                                                                                                          |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1438624              | 1994, Technical Chemistry file - BAY NTN 33893 Technical, DACO: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6                                                                                                                       |
| 1438697              | 1997, Technical Chemistry file - Supplementary Chemistry Requirements for the Registration Of BAY NTN 33893 Technical, DACO: 2.1, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9 |

#### A.2.0 Human Health Assessment

#### A.2.1 Toxicological Assessment

| PMRA Document Number | Reference                                                                                                                                                     |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 591475               | 2001, A Developmental Neurotoxicity Screening Study with Technical Grade Imidacloprid in Wistar Rats, DACO: 4.5.12, 4.5.14                                    |
| 1039613              | 1994, An Acute Oral Neurotoxicity Screening Study With Technical Grade Imidacloprid (NTN 33893) In Rats., DACO: 4.5.12                                        |
| 1039643              | 1994, A Subchronic Dietary Neurotoxicity Screening Study with Technical Grade Imidacloprid (NTN 33893) in Fischer 344 Rats., DACO: 4.5.13                     |
| 1039650              | 1994, An Acute Oral Neurotoxicity Screening Study With Technical Grade Imidacloprid (NTN 33893) In Rats., DACO: 4.5.12                                        |
| 1039652              | 1994, A Subchronic Dietary Neurotoxicity Screening Study with Technical Grade Imidacloprid (NTN 33893) in Fischer 344 Rats., DACO: 4.5.13                     |
| 1155681              | NTN 33893 Technical: Subchronic Toxicity Study On Dogs In Oral Administration (Thirteen-Week Feeding Study) (100176;18732) (Imidacloprid/Admire), DACO: 4.3.1 |
| 1155682              | NTN 33893: Subchronic Toxicity Study On Wistar Rats (Adminstration In The Feed For 96 Days) (100036;18187) (Imidacloprid/Admire), DACO: 4.3.1                 |
| 1155687              | NTN 33893 Technical: (Proposed C.N. Imidacloprid) Multiple Generation Reproduction Study In Rats (100647;R5097;RCC087063;T 7025163)(Admire), DACO: 4.5.1      |
| 1155688              | NTN 33893 Technical: (Proposed C.N. Imidacloprid) Multiple Generation Reproduction Study In Rats (100647;R5097;RCC087063;T 7025163)(ADMIRE), DACO: 4.5.1      |



| PMRA Document Number | Reference                                                                                                                                                                                                          |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1155689              | NTN 33893 (Proposed Common Name: Imidacloprid) Subacute Inhalation Toxicity Study On The Rat According To Oecd Guideline No.412 (100262;18199;T 3027635)(Admire), DACO: 4.3.6                                      |
| 1155690              | NTN 33893 Technical: Study For Subacute Dermal Toxicity In The Rabbit (100688;19152) (Imidacloprid/Admire), DACO: 4.3.4                                                                                            |
| 1155691              | 28-Day Oral Range-Finding Toxicity (Feeding) Study With NTN33893 Techn. In The Dog (99656;RCC 084993;T 6025018;R 4196) (Imidacloprid/Admire), DACO: 4.3.1                                                          |
| 1155693              | NTN 33893 Sister Chromatid Exchange In Bone Marrow Of Chinese Hamsters In Vivo Supplement Report To June 16 1989 Report (EPA MRID# 42256346)(99257-1;18093A;T8030302) (Imidacloprid/Admire), DACO: 4.5.4           |
| 1155694              | Final Report Sister Chromatid Exchange Assay In Chinese Hamster Ovary Cells (99676;1149;T8302.334) (Imidacloprid/Admire), DACO: 4.5.4                                                                              |
| 1155695              | WAK 3839 Subchronic Toxicological Study On Rats (Twelve-Week Administration In Drinking Water) (101949;21140;T 5033324) (Imidacloprid/Admire), DACO: 4.3.1                                                         |
| 1155697              | NTN 33893 Carcinogenicity Study On B6C3F1 Mice (Administration In The Food For 24 Months) (100693;19931) (Imidacloprid/Admire), DACO: 4.4.1,4.4.2                                                                  |
| 1155698              | Embryotoxicity Study (Including Teratogenicity) With NTN 33893 Technical In The Rat Part I Revised Edition (98571;083496;148004;T 5032695) (Imidacloprid/Admire), DACO: 4.5.2                                      |
| 1155699              | Embryotoxicity Study (Including Teratogenicity) With NTN 33893 Technical In The Rabbit Part I Revised Edition (98572;083518) (Imidacloprid/Admire), DACO: 4.5.2                                                    |
| 1155700              | Mouse Germ-Cell Cytogenetic Assay With NTN 33893 (Imidacloprid/Admire) (102654;R 5063), DACO: 4.5.4                                                                                                                |
| 1155701              | NTN 33893 In Vivo Cytogenetic Study Of The Bone Marrow In Chinese Hamster To Evaluate For Induced Clastogenic Effects (100021;18557;T 8032562)(Imidacloprid/Admire), DACO: 4.5.4                                   |
| 1155702              | WAK 3839 Mutagenicity Study For The Detection Of Induced Forward Mutations In The Cho-HgpRT Assay In Vitro (17757;100661;T 7030167) (Imidacloprid/Admire), DACO: 4.5.4                                             |
| 1155703              | Chromosome Aberration Assay In Chinese Hamster V79 Cells In Vitro With WAK 3839 (100666;R4849;CCR 151200) (Imidacloprid/Admire), DACO: 4.5.4                                                                       |
| 1155705              | NTN 33893 Carcinogenicity Study In B6C3F1 Mice (Supplementary Mtd Testing For Study T 5025710 With Administration In Diet Over A 24-Month Period)(101929;20769;T 4029986) (Imidacloprid/Admire), DACO: 4.4.1,4.4.2 |

| PMRA Document Number | Reference                                                                                                                                                               |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1155706              | NTN 33893 Mutagenicity Study For The Detection Of Induced Forward Mutations In The CHO-HGPRT Assay In Vitro (98587;17578;T 5029536) (Imidacloprid/Admire), DACO: 4.5.4  |
| 1155707              | WAK 3839 Mutagenicity Study For The Detection Of Induced Forward Mutations In The V79-HGPRT Assay In Vitro (100662;18281) (Imidacloprid/Admire), DACO: 4.5.4            |
| 1155708              | WAK 3839 Micronucleus Test On The Mouse After Oral Application (100663;184060 (Imidacloprid/Admire), DACO: 4.5.4                                                        |
| 1155709              | WAK 3839 OR NTN 37571 Micronucleus Test On The Mouse After Intraperitoneal Injection (100664;18407) (Imidacloprid/Admire), DACO: 4.5.4                                  |
| 1155710              | NTN 33893 Salmonella/Microsome Test To Evaluate For Point Mutagenic Effects (98570;17577;T 6030111) (Imidacloprid/Admire), DACO: 4.5.4                                  |
| 1155711              | NTN 33893 In Vitro Cytogenetic Study With Human Lymphocytes For The Detection Of Induced Clastogenic Effects (99262;18092;T 6029654) (Imidacloprid/Admire), DACO: 4.5.4 |
| 1155713              | Unscheduled DNA Synthesis In Primary Hepatocytes Of Male Rats In Vitro With WAK 3839 (100665;R4746;CCR 137002) (Imidacloprid/Admire), DACO: 4.5.4                       |
| 1155714              | NTN 33893 Reverse Mutation Assay (Salmonella Typhimurium And Escherichia Coli) (101276;90A032) (Imidacloprid/Admire), DACO: 4.5.4                                       |
| 1155715              | WAK 3839 Reverse Mutation Assay (Salmonella Typhimurium And Escherichia Coli) (100668;90A015;RA90035) (Imidacloprid/Admire), DACO: 4.5.4                                |
| 1155717              | NTN 33893 REC-Assay With Spores In The Bacterial System (101275;90A013) (Imidacloprid/Admire), DACO: 4.5.4                                                              |
| 1155718              | NTN 33893 Test On S. Cerevisiae D7 To Evaluate For Induction Of Mitotic Recombination (102653;16832) (Imidacloprid/Admire), DACO: 4.5.4                                 |
| 1155720              | NTN 33893 Study For Acute Inhalation Toxicity In The Rat In Accordance With Oecd Guideline No. 403 (99806;16777) (Imidacloprid/Admire), DACO: 4.2.3                     |
| 1155724              | NTN 33893 Study For Acute Oral Toxicity To Rats (100040;18594) (Imidacloprid/Admire), DACO: 4.2.1                                                                       |
| 1155729              | NTN 33893 (C.N. Imidacloprid (Proposed)) Study For Acute Dermal Toxicity To Rats (100041;18532) (Admire), DACO: 4.2.2                                                   |
| 1155731              | NTN 33893 Study For Irritant/Corrosive Potential On The Eye (Rabbit) According To Oecd Guideline No. 405 (99679;16456;T 8025515) (Imidacloprid/Admire), DACO: 4.2.4     |
| 1155738              | NTN 37571 In Vitro Cytogenetic Assay Measuring Chromosome Aberrations In CHO-K1 Cells (100678;RP880088) (Imidacloprid/Admire), DACO: 4.5.4                              |

| PMRA Document Number | Reference                                                                                                                                                                                                                                                      |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1155747              | NTN 33893 Technical Study For Skin Sensitising Effect On Guinea Pigs (Maximization Test) (99800;16533;T 9025651) (Imidacloprid/Admire), DACO: 4.2.6                                                                                                            |
| 1155751              | NTN 37571 Micronucleus Test On The Mice After Oral Treatment Pilot Study (100680;RS88040) (Imidacloprid/Admire), DACO: 4.5.4                                                                                                                                   |
| 1155753              | NTN 37571 Micronucleus Test On The Mice After I.P. Treatment Pilot Study (100679;RS88041) (Imidacloprid/Admire), DACO: 4.5.4                                                                                                                                   |
| 1155754              | Mutagenicity Test On NTN 33893 In The Rat Primary Hepatocyte Unscheduled Dna Synthesis Assay (98573;HLA 10237-0-447;T6027610;4631) Final Report (Imidacloprid/Admire), DACO: 4.5.4                                                                             |
| 1155755              | NTN 33893 Micronucleus Test On The Mouse To Evaluate For Clastogenic Effects (102652;16837) (Imidacloprid/Admire), DACO: 4.5.4                                                                                                                                 |
| 1155757              | NTN 33893 (Proposed Common Name: Imidacloprid) Chronic Toxicity And Carcinogenicity Studies On Wistar Rats (Administration In Food Over 24 Months) Supplementary MTD Study For Two-Year Study T 1025699 (101931;20541;T3030055;T 1025699) (Admire), DACO: 4.4. |
| 1155758              | 52-Week Oral Toxicity (Feeding) Study With Ntn 33893 Technical In The Dog (085004;T 7025019;R 4856;100015) (Imidacloprid/Admire), DACO: 4.4.1                                                                                                                  |
| 1155760              | NTN 33893 (Proposed Common Name: Imidacloprid) Chronic Toxicity And Cancerogenicity Studies On Wistar Rats (Administration In Food Over 24 Months) (100652;19925)(Admire)(Cont'd On Roll# 1315), DACO: 4.4.1                                                   |
| 1155761              | (Cont'd From Roll#1314) NTN 33893 (Proposed Common Name: Imidacloprid) Chronic Toxicity And Cancerogenicity Studies On Wistar Rats (Administration In Food Over 24 Months) (100652;19925) (Admire), DACO: 4.4.1,4.4.2                                          |
| 1155769              | Methylene- [14-C] Imidacloprid: Metabolism Part Of The General Metabolism Study In The Rat (101999;M 182 0176-5) (Admire), DACO: 4.5.9, 6.4                                                                                                                    |
| 1155781              | Imidacloprid- WAK 3839: Comparison Of Biokinetic Behaviour And Metabolism In The Rat Following Single Oral Dosage And Investigation Of The Metabolism After Chronic Feeding Of Imidacloprid To Rats And Mice (100645;PF 3432;M 71810016)(Admire), DACO: 4.5.9  |
| 1155782              | [Imidazolidine-4,5-14C] Imidacloprid: Investigation Of The Biokinetic Behaviour And Metabolism In The Rat (102617;PF 3629;M 31819004) (Admire), DACO: 4.5.9, 6.4                                                                                               |
| 2030936              | 1993, NTN 38014 - Acute oral toxicity study on rats, DACO: 4.2.1                                                                                                                                                                                               |
| 2030937              | 1991, NTN 33519 - Acute oral toxicity study on rats, DACO: 4.2.1                                                                                                                                                                                               |
| 2030938              | 1993, NTN 35884 - Acute oral toxicity study on rats, DACO: 4.2.1                                                                                                                                                                                               |
| 2030939              | 1991, NTN 33893 AMP (proposed c.n.: Imidacloprid) - Study for acute oral toxicity to rats, DACO: 4.2.1                                                                                                                                                         |
| 2030940              | 1991, NTN 33893 CNS (c.n.: Imidacloprid (proposed) - Study for acute oral toxicity in rats, DACO: 4.2.1                                                                                                                                                        |



| PMRA Document Number | Reference                                                                                                                |
|----------------------|--------------------------------------------------------------------------------------------------------------------------|
| 2030941              | 1991, NTN 38014 - Reverse mutation assay (Salmonella typhimurium and Escherichia coli), DACO: 4.5.4                      |
| 2030942              | 1991, NTN 33519 - Reverse mutation assay (Salmonella typhimurium and Escherichia coli), DACO: 4.5.4                      |
| 2030943              | 1993, NTN 35884 - Reverse mutation assay (Salmonella typhimurium and Escherichia coli), DACO: 4.5.4                      |
| 2030947              | 1987, (14C)-NTN 33893: Biokinetic part of the 'General metabolism study' in the rat, DACO: 4.5.9                         |
| 2182455              | 2011, Imidacloprid: Evaluation In The In Vitro (HELA-9903) Estrogen Receptor Transcriptional Activation Assay, DACO: 4.8 |
| 2182447              | 2011, Evaluation Of Imidacloprid In The Androgen Receptor Binding Assay, DACO: 4.8                                       |
| 2182448              | 2011, Evaluation Of Imidacloprid In The H295R Steroidogenesis Assay, DACO: 4.8                                           |
| 2182449              | 2011, Evaluation Of Imidacloprid In The Aromatase Assay, DACO: 4.8                                                       |
| 2182450              | 2012, Imidacloprid Evaluation In The Immature Rat Uterotrophic Assay, DACO: 4.8                                          |
| 2182451              | 2012, Evaluation Of Imidacloprid In The Estrogen Receptor Binding Assay, DACO: 4.8                                       |
| 2182452              | 2012, Imidacloprid Evaluation In The Hershberger Bioassay, DACO: 4.8                                                     |

#### A.2.2 Dietary Assessment

| PMRA Document Number | Reference                                                                                                                                                                                                                                                                                                            |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1155790              | Review Of The Storage Stability Data Of NTN33893 And Metabolites In Plant Matrices (103847) (Admire). Author: T. Clark. Study Finalized: October 1, 1992. Performing Laboratory: Bayer Ag, Leverkusen-Bayerwerk, Germany., DACO: 7.3                                                                                 |
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| 2031109              | 2000, Determination of residues of Imidacloprid on sweet cherry after spray application of Confidor 200 SL in the field in Italy and Spain (fruit, washed fruit, preserve, stoned fruit, washings) - processing study, DACO: 7.4.1 |
| 2031111              | 2000, Determination of residues of Confidor 200 SL [a.s. imidacloprid] on plum following spray application in the field in Spain, DACO: 7.4.1                                                                                      |
| 2031114              | 1996, Determination of residues of Confidor 200 SL on plum following spray application in France, DACO: 7.4.1                                                                                                                      |
| 2031116              | 1998, Determination of residues of Confidor (200 SL) on plum in the field in Great Britain and France, DACO: 7.4.1                                                                                                                 |
| 2031118              | 1999, Determination of residues of Confidor 70 WG on plum following spray application in the field in Germany, Great Britain and France, DACO: 7.4.1                                                                               |
| 2031120              | 2002, Imidacloprid: Magnitude of the residue on plum, DACO: 7.4.1                                                                                                                                                                  |
| 2031128              | 1993, Determination of residues of Confidor 200 SL in/on plums under actual use conditions in Italy, DACO: 7.4.1                                                                                                                   |
| 2031130              | 1990, NTN 33893; 200 SL; orange; Spain; BBA, DACO: 7.4.1                                                                                                                                                                           |
| 2031131              | 2000, Determination of residues of imidacloprid on plum after spray application of Confidor 200 SL in the field in Italy and France, DACO: 7.4.1                                                                                   |
| 2031133              | 1997, Determination of residues of imidacloprid on plum after application of a Confidor-200SL-formulation in France, DACO: 7.4.1                                                                                                   |
| 2031135              | 2001, NTN 33893; 200 SL; apricot; France; BBA, DACO: 7.4.1                                                                                                                                                                         |
| 2031137              | 1999, Admire 2F - Magnitude of the residue in grapes, DACO: 7.4.1                                                                                                                                                                  |
| 2031141              | 1999, Determination of residues of Confidor 200 SL [A.S. imidacloprid] on grape following spray application in the field in Portugal, DACO: 7.4.1                                                                                  |
| 2031144              | 1998, Determination of residues of Confidor 200 SL on grape (must and wine) following spray application in the field in Portugal, DACO: 7.4.1                                                                                      |
| 2031148              | 1999, Determination of residues of Confidor 200 SL [A.S. imidacloprid] on grape (must and wine) following spray application in the field in Portugal, DACO: 7.4.1                                                                  |
| 2031150              | 1992, Imidacloprid (240 FS) - Magnitude of the residue on grape, DACO: 7.4.1                                                                                                                                                       |
| 2031154              | 1993, Imidacloprid (75WP & 240FS) - Magnitude of the residue on grape (Addendum 1), DACO: 7.4.1                                                                                                                                    |
| 2031159              | 2001, Determination of residues of imidacloprid on grape after spray application of Confidor 200 SL in the field in Portugal, Spain and Italy, DACO: 7.4.1                                                                         |
| 2031161              | 1995, Admire 2F - Magnitude of the residue in citrus (soil treatment), DACO: 7.4.1                                                                                                                                                 |

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| 2031165              | 2001, Determination of residues of imidacloprid on grape (bunch of grape, berry, washed berry, juice, washing water, pomace and retentate) after spray application of Confidor 200 SL in the field in Portugal and Italy, DACO: 7.4.1,7.4.5 |
| 2031168              | 1998, Determination of residues of Confidor 200 SL on grape following spray application in the field in Portugal, DACO: 7.4.1                                                                                                               |
| 2031170              | 1992, Imidacloprid (240FS) - Magnitude of the residue on processed grape commodities, DACO: 7.4.1,7.4.5                                                                                                                                     |
| 2031174              | 2002, Imidacloprid: Magnitude of the residue on strawberry, DACO: 7.4.1                                                                                                                                                                     |
| 2031179              | 2001, Determination of residues of Confidor 200 SL (NTN 33893) on strawberry following application with irrigation water in the field in Italy, France and Spain, DACO: 7.4.1                                                               |
| 2031182              | 2001, Determination of residues of imidacloprid on strawberry after application of Confidor 200 SL in the field in France, Spain and Italy, DACO: 7.4.1                                                                                     |
| 2031186              | 2000, Determination of residues of imidacloprid on strawberry after application of Confidor 200 SL in the field in Italy, DACO: 7.4.1                                                                                                       |
| 2031188              | 2000, Imidacloprid : Magnitude of the residue on cranberry, DACO: 7.4.1                                                                                                                                                                     |
| 2031193              | 2001, Imidacloprid: Magnitude of the residue on lowbush blueberry, DACO: 7.4.1                                                                                                                                                              |
| 2031198              | 2001, Imidacloprid: Magnitude of the residue on blueberry (high bush), DACO: 7.4.1                                                                                                                                                          |
| 2031208              | 1995, Admire 2F - Magnitude of the residue on foliar treated citrus, DACO: 7.4.1                                                                                                                                                            |
| 2031209              | 2007, Magnitude of residues in/on blueberries treated with three applications of the insecticide concept 850D with a 14 day PHI, DACO: 7.4.1                                                                                                |
| 2031210              | 1993, Imidacloprid (2 F) - Magnitude of the residue in mango, DACO: 7.4.1                                                                                                                                                                   |
| 2031212              | 2002, Imidacloprid : Magnitude of the residue on sapote (mamey), DACO: 7.4.1                                                                                                                                                                |
| 2031215              | 2004, Imidacloprid - Magnitude of the residue on avocado, DACO: 7.4.1                                                                                                                                                                       |
| 2031216              | 2005, Imidacloprid: Magnitude of the residue on banana, DACO: 7.4.1                                                                                                                                                                         |
| 2031218              | 2002, Imidacloprid: Magnitude of the residue on guava, DACO: 7.4.1                                                                                                                                                                          |
| 2031222              | 2002, Imidacloprid: Magnitude of the residue on papaya, DACO: 7.4.1                                                                                                                                                                         |
| 2031223              | 2002, Imidacloprid: Magnitude of the residue on papaya (Mexico study), DACO: 7.4.1                                                                                                                                                          |
| 2031224              | 2000, Contract trial to determine the level of imidacloprid residues in potatoes cv Sebago following one application of Confidor 200 SC applied in-furrow at planting, DACO: 7.4.1                                                          |

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| 2031225              | 1992, Trials on the residue behaviour of Gaucho as seed dressing in potatoes, DACO: 7.4.1                                                                                                                                                               |
| 2031229              | 1996, Addendum 1 - Admire 2F - Magnitude of the residue on foliar-treated citrus - Additional field trials, DACO: 7.4.1                                                                                                                                 |
| 2031231              | 1993, Determination of residues of Gaucho 350 FS in/on potato and processing commodities under actual use conditions in Germany, DACO: 7.4.1, 7.4.5                                                                                                     |
| 2031233              | 1999, Determination of residues of Confidor 200 SL on potato following spray application in the field in Germany, France and Netherlands, DACO: 7.4.1                                                                                                   |
| 2031235              | 1996, Determination of residues of Gaucho 350 FS in/on potato under actual use conditions in Spain, DACO: 7.4.1                                                                                                                                         |
| 2031236              | 1999, Admire 2F/ Gaucho 2 percent dust - Magnitude of the residue in potatoes - Admire 2F in-furrow versus Gaucho 2 percent dust treatments, DACO: 7.4.1                                                                                                |
| 2031239              | 1999, To determine the level of residues of imidacloprid in sweet potato following 3 applications of Confidor 350 SC applied as a dilute spray to run off and at a rate per hectare. Redlands Research Station, Cleveland Queensland, 1998, DACO: 7.4.1 |
| 2031240              | 1996, Determination of residues of Gaucho 350 FS in/on potato under actual use conditions in Italy, DACO: 7.4.1                                                                                                                                         |
| 2031241              | 1993, Determination of residues of Gaucho 350 FS in/on potato under actual use conditions in the Federal Republic of Germany, DACO: 7.4.1                                                                                                               |
| 2031242              | 1996, Determination of residues of Zelmone (350 FS) in/on potato under actual use conditions in Great Britain, DACO: 7.4.1                                                                                                                              |
| 2031243              | 1992, NTN 33893; 200 SL; cucumber; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                              |
| 2031244              | 1992, NTN 33893; 200 SL; cucumber; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                              |
| 2031245              | 1996, Addendum 1 - Admire 2F - Magnitude of the residue in citrus (soil treatment) - Additional field trials, DACO: 7.4.1                                                                                                                               |
| 2031246              | 1992, NTN 33893; 200 SL; cucumber; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                              |
| 2031247              | 1992, NTN 33893; 200 SL; tomato; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                                |
| 2031248              | 1992, NTN 33893; 200 SL; tomato; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                                |
| 2031249              | 1996, Admire 240 FS- Magnitude of the residue on tomatoes, DACO: 7.4.1                                                                                                                                                                                  |
| 2031250              | 1996, Determination of residues of Admire 70 WG in tomatoes following drip irrigation application in the Netherlands, DACO: 7.4.1                                                                                                                       |
| 2031252              | 1996, Determination of residues of Orbit 0.25. XX in tomatoes following stick application in the Netherlands, DACO: 7.4.1                                                                                                                               |
| 2031253              | 1996, Determination of residues of imidacloprid in tomatoes (regular/large and cherry), DACO: 7.4.1                                                                                                                                                     |

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| 2031255              | 1996, Determination of residues of Confidor 200 SL in aubergines and tomatoes following drip irrigation application or spray application in Italy (greenhouse and field trials), DACO: 7.4.1                             |
| 2031256              | 1995, Determination of residues of Admire 70 WG following drip irrigation application and Orbit 0.25 PR following stick application in cucumbers, tomatoes and peppers in the Netherlands, DACO: 7.4.1                   |
| 2031258              | 1993, Determination of residues of Confidor 200 SL in/on melon, pepper, tomato and watermelon under actual use conditions in Spain, DACO: 7.4.1                                                                          |
| 2031259              | 1995, Addendum 1 Admire 2 F - Magnitude of the residue on orange processed commodities wet pulp residue, DACO: 7.4.1, 7.4.5                                                                                              |
| 2031260              | 1993, Determination of residues of Confidor 200 SL in/on melon, tomato, pepper and watermelon under actual use conditions in Italy, DACO: 7.4.1                                                                          |
| 2031261              | 1993, Imidacloprid (2.5 GR & 2 F) - Magnitude of the residue on tomato, DACO: 7.4.1                                                                                                                                      |
| 2031268              | 1993, Determination of residues of Confidor 200 SL in/on tomato under actual use conditions in France, DACO: 7.4.1                                                                                                       |
| 2031272              | 1997, Determination of residues of imidacloprid after application of Confidor 200 SL on tomato in Italy (greenhouse experiments), DACO: 7.4.1                                                                            |
| 2031274              | 1995, Determination of residues of Confidor 200 SL on watermelon and tomato following spray application in Italy, DACO: 7.4.1                                                                                            |
| 2031275              | 1993, Determination of residues of Confidor 200 SL in/on tomato under actual use conditions in Spain, DACO: 7.4.1                                                                                                        |
| 2031276              | 2000, Determination of residues of imidacloprid on tomato and aubergine after application of Confidor 200 SL in the greenhouse in Italy and Portugal, DACO: 7.4.1                                                        |
| 2031277              | 1999, Determination of residues of Confidor (200 SL) on aubergine and tomato in the field in Italy, DACO: 7.4.1                                                                                                          |
| 2031278              | 2000, Determination of residues of imidacloprid on tomato and aubergine after application of Confidor 200 SL in the field in Italy and Spain, DACO: 7.4.1                                                                |
| 2031279              | 2002, Determination of residues of imidacloprid in/on tomato following spray application of Confidor Forte SL 200 in the greenhouse in Belgium, Italy and the Netherlands, DACO: 7.4.1                                   |
| 2031281              | 1996, Residue of imidacloprid in citrus (orange), DACO: 7.4.1                                                                                                                                                            |
| 2031282              | 2002, Determination of residues of imidacloprid in/on tomato following spray application of Confidor Forte 200 SL in the greenhouse in Germany, Great Britain, Italy, Belgium, Portugal and the Netherlands, DACO: 7.4.1 |



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| 2031286              | 2002, Determination of residues of imidacloprid in/on Tomato following spray application of Confidor 200 SL in the greenhouse in the Netherlands, Southern France, Italy, Spain and Portugal, DACO: 7.4.1 |
| 2031290              | 2002, Imidacloprid: Magnitude of the residue on tomato (Greenhouse), DACO: 7.4.1                                                                                                                          |
| 2031292              | 1996, Residue of imidacloprid in tomato, DACO: 7.4.1                                                                                                                                                      |
| 2031295              | 2006, Confidor Energy - Magnitude of the residue in/on tomato, DACO: 7.4.1                                                                                                                                |
| 2031300              | 1990, NTN 33893; 200 SL; pepper; Spain; BBA, DACO: 7.4.1                                                                                                                                                  |
| 2031302              | 1990, NTN 33893; 200 SL; pepper; Spain; BBA, DACO: 7.4.1                                                                                                                                                  |
| 2031304              | 1996, Determination of residues of Confidor 200 SL on pepper following spray application and irrigation in Italy, DACO: 7.4.1                                                                             |
| 2031305              | 2002, Determination of residues of imidacloprid in/on pepper following spray application of Confidor Forte 200 SL in the greenhouse in Spain, Germany, Netherlands and Italy, DACO: 7.4.1                 |
| 2031306              | 1993, Imidacloprid (2.5GR & 2F) - Magnitude of the residue on pepper, DACO: 7.4.1                                                                                                                         |
| 2031307              | 1993, Determination of residues of Confidor 200 SL in/on mandarine under actual use conditions in Spain, DACO: 7.4.1                                                                                      |
| 2031308              | 1993, Imidacloprid (2.5 GR & 2 F) - Magnitude of the residue on cauliflower, DACO: 7.4.1                                                                                                                  |
| 2031309              | 1996, Determination of imidacloprid residues in cauliflower samples, DACO: 7.4.1                                                                                                                          |
| 2031310              | 1994, Determination of residues of Confidor 200 SL in/on cauliflower following spray application in France, DACO: 7.4.1                                                                                   |
| 2031312              | 1996, Determination of Imidacloprid residues found in cauliflowers cv.Arka, following a two spray program of Confidor 350 SC.Baldivis, Western Australia, 1996., DACO: 7.4.1                              |
| 2031315              | 2001, Determination of residues of Confidor 200 SL in cauliflower following soil drench application in France, DACO: 7.4.1                                                                                |
| 2031317              | 1994, Determination of residues of Confidor 200 SL in/on cauliflower following spray application in Italy, DACO: 7.4.1                                                                                    |
| 2031318              | 1997, Determination of residues of Imidacloprid on cauliflower in France after application of a Confidor 200 SL formulation, DACO: 7.4.1                                                                  |
| 2031319              | 1998, Determination of residues of Confidor (200 SL) in/on broccoli and cauliflower in the field in France, DACO: 7.4.1                                                                                   |
| 2031320              | 1998, Determination of residues of Confidor (70 WG) on white cabbage, cauliflower and chinese cabbage in the field in the Federal Republic of Germany, DACO: 7.4.1                                        |

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| 2031322              | 1996, Determination of residues of Confidor 200 SL in round cabbage and cauliflower following soil drench application in France, DACO: 7.4.1                                  |
| 2031323              | 1995, Determination of residues of Confidor 200 SL on mandarin following spray application in Spain, DACO: 7.4.1                                                              |
| 2031324              | 2001, Determination of residues of Imidacloprid on cauliflower following spray application of Confidor 200 SL in the field in Spain and Italy, DACO: 7.4.1                    |
| 2031325              | 1997, Determination of residues of Imidacloprid after application of a Confidor-200SL-formulation on cauliflower in Italy, DACO: 7.4.1                                        |
| 2031326              | 1999, Determination of residues of Gaucho 70 WS on cauliflower following seed treatment in the field in Belgium, Germany and Great Britain, DACO: 7.4.1                       |
| 2031327              | 1996, Imidacloprid (NTN 33893) : Magnitude of the residue in/on melons - 1992, DACO: 7.4.1                                                                                    |
| 2031330              | 1996, Imidacloprid (NTN 33893) : Magnitude of the residue in/on melon - 1993, DACO: 7.4.1                                                                                     |
| 2031333              | 2002, Determination of residues of imidacloprid in/on melon and watermelon after spray application of Confidor Forte 200 SL in the greenhouse in Italy and Spain, DACO: 7.4.1 |
| 2031335              | 2002, Determination of residues of imidacloprid in/on water melon after spray application of Confidor Forte 200 SL in the greenhouse in Italy, DACO: 7.4.1                    |
| 2031338              | 2000, Determination of residues of Confidor 200 SL [A.S. Imidacloprid] on watermelon and melon in the field in Italy, DACO: 7.4.1                                             |
| 2031339              | 1996, Determination of residues of Confidor 200 SL on watermelon and melon following drip irrigation application or spray application in Italy and Spain, DACO: 7.4.1         |
| 2031341              | 1996, Residues of imidacloprid in rockmelons, DACO: 7.4.1                                                                                                                     |
| 2031342              | 1996, Determination of residues of Confidor 200 SL in/on clementine following spray application in Italy, DACO: 7.4.1                                                         |
| 2031344              | 1993, Determination of residues of Confidor 200 SL in/on melon and watermelon under actual use conditions in Spain and Italy, DACO: 7.4.1                                     |
| 2031347              | 1994, Determination of imidacloprid residues in rockmelons, DACO: 7.4.1                                                                                                       |
| 2031349              | 1995, Determination of residues of Confidor 200 SL in/on melons following spray application in Italy, DACO: 7.4.1                                                             |
| 2031350              | 1995, Determination of residues of Confidor 200 SL in/on melons following spray or drip irrigation application in Spain, DACO: 7.4.1                                          |
| 2031352              | 2000, Determination of residues of imidacloprid on melon and watermelon after application with irrigation water of Confidor 200 SL in the field in Italy, DACO: 7.4.1         |

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| 2031353              | 2001, Determination of residues of imidacloprid in/on watermelon after spray application of Confidor 200 SL in the field in Greece, DACO: 7.4.1                                                                                      |
| 2031359              | 1995, Residues of imidacloprid in broccoli, DACO: 7.4.1                                                                                                                                                                              |
| 2031360              | 1996, Determination of residues of imidacloprid residues in broccoli, DACO: 7.4.1                                                                                                                                                    |
| 2031363              | 1997, Determination of residues of imidacloprid on broccoli in Italy after treatment with a Confidor-200 SL-formulation, DACO: 7.4.1                                                                                                 |
| 2031367              | 2001, Determination of residues of imidacloprid in/on broccoli after spray application of Confidor 200 SL in the field in Spain, DACO: 7.4.1                                                                                         |
| 2031368              | 1990, NTN 33893; 200 SL; mandarin; Spain; BBA, DACO: 7.4.1                                                                                                                                                                           |
| 2031369              | 1993, Imidacloprid (2.5 GR & 2 F)- Magnitude of the residue on broccoli, DACO: 7.4.1                                                                                                                                                 |
| 2031374              | 1993, Imidacloprid (2.5GR & 2F) - Magnitude of the residue on cabbage, DACO: 7.4.1                                                                                                                                                   |
| 2031379              | 1994, Determination of residues of Confidor 200 SL in white cabbage following soil drench application in France, DACO: 7.4.1                                                                                                         |
| 2031380              | 1997, Determination of imidacloprid residues in cabbage heads after three applications of Confidor 350 SC to cabbage cv. Jupiter, DACO: 7.4.1                                                                                        |
| 2031381              | 1997, Determination of residues of Confidor (200 SL) on round cabbage in France, DACO: 7.4.1                                                                                                                                         |
| 2031382              | 1994, Determination of residues of Confidor 200 SL in/on headed cabbage under actual use conditions in France, DACO: 7.4.1                                                                                                           |
| 2031383              | 2006, Confidor Energy - Magnitude of the residue in/on cabbage, DACO: 7.4.1                                                                                                                                                          |
| 2031384              | 1999, Determination of residues of Confidor 70 WG on brussels sprouts following drench application in the field in Germany, France, Great Britain and Belgium, DACO: 7.4.1                                                           |
| 2031385              | 1998, Determination of residues of Admire 70 WG on brussels sprouts following drench application in the field in Germany, Benelux and France, DACO: 7.4.1                                                                            |
| 2031386              | 1997, Determination of residues of Confidor 200 SL on brussels sprouts in the field in France, DACO: 7.4.1                                                                                                                           |
| 2031387              | 2005, IR-4 Minor use submission in support of a tolerance for imidacloprid in or on tree nuts (crop group 14) and pistachio - Provado 1.6F - Magnitude of the residue in almonds and pecans (crop group 14 - tree nuts), DACO: 7.4.1 |
| 2031388              | 1996, Residues resulting with Confidor 350 SC on brussels sprouts cv. Roger., DACO: 7.4.1                                                                                                                                            |
| 2031389              | 1996, Determination of imidacloprid residues in brussel sprouts, DACO: 7.4.1                                                                                                                                                         |
| 2031390              | 1995, Determination of imidacloprid in brussel sprouts, DACO: 7.4.1                                                                                                                                                                  |

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| 2031391              | 2006, Confidor Energy - Magnitude of the residue in/on Brussel sprouts, DACO: 7.4.1                                                                                                |
| 2031396              | 1998, Determination of residues of Confidor 70 WG on cauliflower, round cabbage, chinese cabbage and red cabbage following drench application in the field in Germany, DACO: 7.4.1 |
| 2031399              | 2000, Determination of residues of Confidor 70 WG on lettuce following drench application in the field in Germany, Benelux and Great Britain, DACO: 7.4.1                          |
| 2031401              | 1996, Determination of residues of Confidor 200 SL on endive and lettuce following spray application or drip irrigation application in Italy and Spain, DACO: 7.4.1                |
| 2031403              | 1997, Determination of residues of Gaucho 70 WS following seed dressing on lettuce in Netherlands, DACO: 7.4.1                                                                     |
| 2031406              | 1995, Determination of residues of Confidor 200 SL in/on lettuce under actual use conditions in Spain, DACO: 7.4.1                                                                 |
| 2031408              | 1995, Determination of residues of Confidor 200 SL in lettuce and endive following soil drench application in France, DACO: 7.4.1                                                  |
| 2031409              | 1993, Determination of residues of Confidor 200 SL in/on almonds under actual use conditions in Italy, DACO: 7.4.1                                                                 |
| 2031410              | 1993, Determination of residues of Confidor 200 SL in/on lettuce under actual use conditions in France, DACO: 7.4.1                                                                |
| 2031412              | 1993, Determination of residues of Confidor 200 SL in/on lettuce under actual use conditions in Spain, DACO: 7.4.1                                                                 |
| 2031413              | 1997, Determination of residues of imidacloprid after treatment with Confidor (200 SL) on lettuce in France and the Federal Republic of Germany, DACO: 7.4.1                       |
| 2031414              | 1997, Determination of residues of imidacloprid on lettuce after application of a Confidor 200 SL formulation in France, DACO: 7.4.1                                               |
| 2031415              | 2001, Determination of residues of imidacloprid after treatment with a Confidor-200 SL-formulation on lettuce in France, DACO: 7.4.1                                               |
| 2031417              | 2002, Determination of residues of imidacloprid in/on lettuce following spray application of Confidor SL 200 in the field in Greece and Italy, DACO: 7.4.1                         |
| 2031418              | 1990, NTN 33893; 200 SL; lettuce; Spain; BBA, DACO: 7.4.1                                                                                                                          |
| 2031419              | 1992, NTN 33893; 5 GR; lettuce; France; BBA, DACO: 7.4.1                                                                                                                           |
| 2031420              | 2002, Determination of residues of imidacloprid in/on lettuce following spray application of Confidor Forte SL 200 in the field in Spain, Italy, Greece and Portugal, DACO: 7.4.1  |
| 2031421              | 1993, Imidacloprid (2.5GR & 2F) - Magnitude of the residue on lettuce, DACO: 7.4.1                                                                                                 |



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| 2031428              | 2002, Determination of residues of imidacloprid in/on almond following spray application of Confidor 200 SL in Italy, Greece and Spain, DACO: 7.4.1                                       |
| 2031429              | 2009, Imidacloprid - Magnitude of the residue on greenhouse lettuce, DACO: 7.4.1                                                                                                          |
| 2031430              | 1993, Determination of residues of Confidor 200 SL in/on beans under actual use conditions in Italy, DACO: 7.4.1                                                                          |
| 2031433              | 1998, Determination of residues of Confidor (200 SC) on kidney bean following spray application in the field in France, Italy and Spain, DACO: 7.4.1                                      |
| 2031434              | 1995, Residues of imidacloprid in faba beans, DACO: 7.4.1                                                                                                                                 |
| 2031435              | 1994, Determination of residues of Confidor 200 SL in/on bean following spray application in Spain, DACO: 7.4.1                                                                           |
| 2031436              | 1996, Determination of residues of Confidor 200 SL in/on bean under actual use conditions in Italy, DACO: 7.4.1                                                                           |
| 2031437              | 1996, Determination of residues of Confidor 200 SL in/on bean under actual use conditions in Spain, DACO: 7.4.1                                                                           |
| 2031438              | 1993, Determination of residues of Confidor 200 SL in/on green beans under actual use conditions in Spain, DACO: 7.4.1                                                                    |
| 2031439              | 2000, Imidacloprid - Magnitude of the residue on succulent beans (i.e., snap beans), DACO: 7.4.1                                                                                          |
| 2031440              | 2001, NTN 33893; 70 WS; bean; Great Britain; BBA, DACO: 7.4.1                                                                                                                             |
| 2031441              | 1994, Admire 2 F - Magnitude of the residue on field treated pecans, DACO: 7.4.1                                                                                                          |
| 2031442              | 2001, NTN 33893; 70 WS; bean; Great Britain; BBA, DACO: 7.4.1                                                                                                                             |
| 2031444              | 2002, Determination of residues of imidacloprid in/on bean after spray application of Confidor Forte SL 200 in the greenhouse in Spain, Southern France, Germany and Belgium, DACO: 7.4.1 |
| 2031445              | 2002, Determination of residues of imidacloprid in/on bean following spray application of Confidor Forte 200 SL in the greenhouse in Southern France and Spain, DACO: 7.4.1               |
| 2031447              | 2004, Determination of residues of imidacloprid in/on kidney bean following spray application of Confidor 200 SL in the field in Italy and Spain, DACO: 7.4.1                             |
| 2031448              | 2004, Determination of residues of imidacloprid in/on kidney bean following spray application of Confidor 200 OD in the field in Italy and Spain, DACO: 7.4.1                             |
| 2031450              | 2004, Determination of residues of imidacloprid in/on kidney bean following spray application of Confidor 200 SL in the field in Italy and Spain, DACO: 7.4.1                             |
| 2031451              | 1996, Residue of imidacloprid in bean grain, DACO: 7.4.1                                                                                                                                  |

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| 2031452              | 1997, NTN 33893; WG 70; bean; Brazil; BBA, DACO: 7.4.1                                                                                                                                                                                                                                             |
| 2031454              | 2000, Imidacloprid: Magnitude of the residue on lima bean, DACO: 7.4.1                                                                                                                                                                                                                             |
| 2031456              | 2009, Determination of residues of Imidacloprid in the forage of lupins, field peas and faba beans following a seed treatment application of Gaucho 600 FS at rates of 72, 105, 144 or 216 g a.i./100 kg of seed, and in the seed and fodder from a rate of 216 g a.i./100 kg of seed, DACO: 7.4.1 |
| 2031457              | 1992, NTN 33893; 200 SL; apple; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                                                                            |
| 2031461              | 1996, Residues of imidacloprid in chick peas (amended), DACO: 7.4.1                                                                                                                                                                                                                                |
| 2031462              | 2001, NTN 33893; 70 WS; pea; Great Britain; BBA, DACO: 7.4.1                                                                                                                                                                                                                                       |
| 2031463              | 2001, NTN 33893; 70 WS; pea; Great Britain; BBA, DACO: 7.4.1                                                                                                                                                                                                                                       |
| 2031464              | 1994, Determination of residues of Confidor 200 SL in/on asparagus under actual use conditions in France, DACO: 7.4.1                                                                                                                                                                              |
| 2031465              | 1997, Determination of residues of Confidor 200 SL on asparagus in the field in France, DACO: 7.4.1                                                                                                                                                                                                |
| 2031466              | 2000, Determination of residues of Confidor 200 SL (A. S. Imidacloprid) on artichoke following spray application in the field in Italy, DACO: 7.4.1                                                                                                                                                |
| 2031467              | 1998, Determination of residues of imidacloprid in/on artichoke after treatment with a Confidor 200 SL formulation in the field in France, DACO: 7.4.1                                                                                                                                             |
| 2031468              | 1998, Determination of residues of Confidor 200 SL on artichoke following spray application in the field in Italy, DACO: 7.4.1                                                                                                                                                                     |
| 2031469              | 1997, Determination of residues of imidacloprid after application of a Confidor-200SL-formulation on artichoke in France, DACO: 7.4.1                                                                                                                                                              |
| 2031470              | 1995, Determination of residues of Confidor 200 SL in/on artichoke following spray application in France, DACO: 7.4.1                                                                                                                                                                              |
| 2031471              | 1994, Residue analysis of Confidor (70 WG) in apples, DACO: 7.4.1                                                                                                                                                                                                                                  |
| 2031473              | 2000, Imidacloprid: Magnitude of the residue on artichoke, DACO: 7.4.1                                                                                                                                                                                                                             |
| 2031474              | 1996, Admire 2F - Magnitude of the residue in celery, DACO: 7.4.1                                                                                                                                                                                                                                  |
| 2031475              | 1998, Evaluation of Confidor 350 SC residues in celery at harvest when applied as a pre transplanting seedling tray drench. Cleveland, Qld. 1997, DACO: 7.4.1                                                                                                                                      |
| 2031476              | 1999, Determination of residues of Gaucho 70 WS on leek following seed treatment in the field in Germany, Great Britain and Belgium, DACO: 7.4.1                                                                                                                                                   |
| 2031477              | 1996, Determination of residues of Gaucho 70 WS on rape following seed dressing application in France, DACO: 7.4.1                                                                                                                                                                                 |
| 2031478              | 1992, NTN 33893; 70 WS; winter rape; Sweden; BBA form, DACO: 7.4.1                                                                                                                                                                                                                                 |
| 2031480              | 1992, NTN 33893; 70 WS; summer rape; Sweden; BBA form, DACO: 7.4.1                                                                                                                                                                                                                                 |

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| 2031481              | 2001, NTN 33893; 70 WS; winter rape; Sweden; BBA form, DACO: 7.4.1                                                                                                                            |
| 2031482              | 1992, NTN 33893; 70 WS; summer rape; Sweden; BBA form, DACO: 7.4.1                                                                                                                            |
| 2031483              | 1992, D 1221 & NTN 33893; 5 GR; winter rape; France; BBA, DACO: 7.4.1                                                                                                                         |
| 2031484              | 1995, Determination of residues of Confidor 200 SL on apple and pear following spray application in Italy, DACO: 7.4.1                                                                        |
| 2031486              | 1992, D 1221 & NTN 33893; 5 GR; winter rape; France; BBA, DACO: 7.4.1                                                                                                                         |
| 2031487              | 1992, D 1221 & NTN 33893; 5 GR; winter rape; France; BBA, DACO: 7.4.1                                                                                                                         |
| 2031488              | 1992, D 1221 & NTN 33893; 5 GR; winter rape; France; BBA, DACO: 7.4.1                                                                                                                         |
| 2031489              | 1992, D 1221 & NTN 33893; 5 GR; winter rape; France; BBA, DACO: 7.4.1                                                                                                                         |
| 2031490              | 1996, Determination of imidacloprid residues in canola, DACO: 7.4.1                                                                                                                           |
| 2031492              | 1998, Determination of residues of imidacloprid in canola, DACO: 7.4.1                                                                                                                        |
| 2031494              | 1995, Determination of imidacloprid residues in Canola, DACO: 7.4.1                                                                                                                           |
| 2031496              | 1999, Determination of residues of Gaucho 350 FS and Gaucho 600 FS on sunflower following seed treatment in the field in Italy, DACO: 7.4.1                                                   |
| 2031497              | 1997, Determination of imidacloprid residues in sunflower grain after one seed dressing application of Gaucho 350 FS to sunflower cv. Hysun 45. Gatton, Queensland. 1995 - 1996., DACO: 7.4.1 |
| 2031498              | 1995, Determination of imidacloprid residues in sunflower seeds, DACO: 7.4.1                                                                                                                  |
| 2031499              | 1992, NTN 33893; 200 SL; apple; France, DACO: 7.4.1                                                                                                                                           |
| 2031500              | 1992, NTN 33893; 350 FS; sunflower; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031501              | 1992, NTN 33893; 350 FS; sunflower; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031503              | 1992, NTN 33893; 350 FS; sunflower; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031504              | 1992, NTN 33893; 350 FS; sunflower; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031505              | 1990, NTN 33893; 70 WS; sunflower; France; BBA, DACO: 7.4.1                                                                                                                                   |
| 2031506              | 1990, NTN 33893; 70 WS; sunflower; France; BBA, DACO: 7.4.1                                                                                                                                   |
| 2031507              | 1992, D 1221 & NTN 33893; 5 GR; sunflower; France; BBA, DACO: 7.4.1                                                                                                                           |
| 2031508              | 1992, D 1221 & NTN 33893; 5 GR; sunflower; France; BBA, DACO: 7.4.1                                                                                                                           |
| 2031510              | 1992, D 1221 & NTN 33893; 5 GR; sunflower; France; BBA, DACO: 7.4.1                                                                                                                           |
| 2031514              | 1992, D 1221 & NTN 33893; 5 GR; processing; sunflower; France; BBA, DACO: 7.4.1, 7.4.5                                                                                                        |

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| 2031515              | 1993, Determination of residues of Confidor 200 SL in/on apple under actual use conditions in France, DACO: 7.4.1                                                                                                                                                     |
| 2031516              | 1990, NTN 33893; 25 WP; hop; Germany; BBA, DACO: 7.4.1                                                                                                                                                                                                                |
| 2031517              | 1995, Determination of residues of Confidor 70 WG in hops following basal spray application in Great Britain, DACO: 7.4.1                                                                                                                                             |
| 2031518              | 2003, Testing of effects of drift residues of imidacloprid SL 200 on the reproduction of aphidius rhopalosiphi (de stefani perez) (hymenoptera, braconidae) under semi-field conditions: Analytical test phas<br>Determination of the residues imidaclop, DACO: 7.4.1 |
| 2031519              | 1993, Determination of residues of Confidor 70 WG in/on hops under actual use conditions in the Federal Republic of Germany, DACO: 7.4.1                                                                                                                              |
| 2031522              | 1992, Trials on the residue behaviour of Confidor in hops, DACO: 7.4.1                                                                                                                                                                                                |
| 2031523              | 1994, Imidacloprid : Magnitude of the residue on hops, DACO: 7.4.1                                                                                                                                                                                                    |
| 2031524              | 1998, Determination of residues of Gaucho 350 FS and Gaucho 600 FS on potato following seed dressing in the field in Italy, DACO: 7.4.1                                                                                                                               |
| 2031525              | 1996, Determination of residues of Confidor 200 SL in/on potato under actual use conditions in Italy, DACO: 7.4.1                                                                                                                                                     |
| 2031526              | 1993, Determination of residues of Zelmone 350 FS in/on potato under actual use conditions in Great Britain, DACO: 7.4.1                                                                                                                                              |
| 2031527              | 1998, Determination of residues of Confidor TM (530 SL) on potato in the field in France, DACO: 7.4.1                                                                                                                                                                 |
| 2031528              | 1993, Determination of residues of Confidor 200 SL in/on apple and pear under actual use conditions in Spain, DACO: 7.4.1                                                                                                                                             |
| 2031529              | 1993, Determination of residues of Confidor 200 SL in/on potato under actual use conditions in Italy, DACO: 7.4.1                                                                                                                                                     |
| 2031530              | 1993, Determination of residues of Gaucho 350 FS in/on potato under actual conditions in Spain, DACO: 7.4.1                                                                                                                                                           |
| 2031531              | 1995, Determination of residues of Confidor 200 SL in potatoes following spray application in Italy, DACO: 7.4.1                                                                                                                                                      |
| 2031532              | 1995, Determination of residues of Confidor 200 SL in/on potato following spray application in Italy, DACO: 7.4.1                                                                                                                                                     |
| 2031533              | 1996, Determination of imidacloprid residues in potatoes, DACO: 7.4.1                                                                                                                                                                                                 |
| 2031534              | 1996, Determination of imidacloprid residues in potatoes, DACO: 7.4.1                                                                                                                                                                                                 |
| 2031535              | 1995, Determination of imidacloprid residues in potatoes, DACO: 7.4.1                                                                                                                                                                                                 |
| 2031536              | 1990, NTN 33893; 200 SL; potato; Germany; BBA, DACO: 7.4.1                                                                                                                                                                                                            |
| 2031537              | 1990, NTN 33893; 70 WS; potato; Great Britain; BBA, DACO: 7.4.1                                                                                                                                                                                                       |
| 2031538              | 1990, NTN 33893; 70 WS; potato; Great Britain; BBA, DACO: 7.4.1                                                                                                                                                                                                       |
| 2031539              | 1992, NTN 33893; 200 SL; apple; Spain; BBA, DACO: 7.4.1                                                                                                                                                                                                               |
| 2031540              | 1992, NTN 33893; 350 FS; potato; Great Britain; BBA, DACO: 7.4.1                                                                                                                                                                                                      |
| 2031541              | 1990, NTN 33893; 70 WS; potato; Great Britain; BBA, DACO: 7.4.1                                                                                                                                                                                                       |



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| 2031542              | 1990, NTN 33893; 200 SL; Potato; Spain; BBA, DACO: 7.4.1                                                                                                                              |
| 2031543              | 1990, NTN 33893; 200 SL; potato; Germany; BBA, DACO: 7.4.1                                                                                                                            |
| 2031544              | 1990, NTN 33893; 200 SL; potato; Germany; BBA, DACO: 7.4.1                                                                                                                            |
| 2031545              | 1990, NTN 33893; 200 SL; potato; Germany; BBA, DACO: 7.4.1                                                                                                                            |
| 2031546              | 1992, NTN 33893; 70 WS; potato; France; BBA, DACO: 7.4.1                                                                                                                              |
| 2031547              | 1993, Determination of residues of Confidor forte 5.0 GR (D 1221 & NTN 33893 5.0 GR or carbofuran & imidacloprid) in/on potato under actual use conditions in Spain, DACO: 7.4.1      |
| 2031548              | 2001, Determination of residues of imidacloprid on potato after seed dressing with Gaucho 600 FS in the field in Germany, France, Italy, Great Britain, Greece and Spain, DACO: 7.4.1 |
| 2031549              | 2006, Confidor Energy - Magnitude of the residue in/on potato, DACO: 7.4.1                                                                                                            |
| 2031550              | 1992, NTN 33893; 200 SL; apple; France, DACO: 7.4.1                                                                                                                                   |
| 2031551              | 1994, Admire (2.5GR & 240FS) - Magnitude of the residue on field-treated potatoes, DACO: 7.4.1                                                                                        |
| 2031552              | 1992, Imidacloprid (2.5 GR & 240 FS)- Magnitude of the residue on potato, DACO: 7.4.1                                                                                                 |
| 2031553              | 2008, Imidacloprid: Magnitude of the residue on sweet potato, DACO: 7.4.1                                                                                                             |
| 2031554              | 1993, Determination of residues of Gaucho 70 WS in/on sugarbeet under actual use conditions in Great Britain, DACO: 7.4.1                                                             |
| 2031555              | 1993, Dissipation of imidacloprid in soil and sugar beet under field conditions after seed dressing of sugar beet, DACO: 7.4.1                                                        |
| 2031556              | 1992, Trials on the residue behaviour of Gaucho in sugarbeets, DACO: 7.4.1                                                                                                            |
| 2031557              | 1990, NTN 33893; 70 WS; sugar beet; France; BBA, DACO: 7.4.1                                                                                                                          |
| 2031558              | 1990, NTN 33893; 70 WS; France; sugar beet; BBA, DACO: 7.4.1                                                                                                                          |
| 2031559              | 1992, Trials on the residue behaviour of Gaucho in sugar beets, DACO: 7.4.1                                                                                                           |
| 2031560              | 1992, NTN 33893; 70 WS; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                   |
| 2031561              | 1990, NTN 33893; 25 WP; apple; Italy; BBA, DACO: 7.4.1                                                                                                                                |
| 2031562              | 1992, NTN 33893; 70 WS; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                   |
| 2031563              | 1992, NTN 33893; 70 WS; sugar beet; Sweden; BBA, DACO: 7.4.1                                                                                                                          |
| 2031564              | 1992, NTN 33893; 70 WS; sugar beet; Sweden; BBA, DACO: 7.4.1                                                                                                                          |
| 2031565              | 1990, NTN 33893; 100 AI; sugar beet; Germany; BBA, DACO: 7.4.1                                                                                                                        |
| 2031566              | 1994, Determination of residues of Gaucho 70 WS in/on sugar beet under actual use conditions in Italy, DACO: 7.4.1                                                                    |
| 2031567              | 1999, Determination of residues in sugar beet from Italy following seed treatment with Gaucho 600 FS and Gaucho 70 WS, DACO: 7.4.1                                                    |

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| 2031568              | 1998, Determination of residues of Gaucho 600 FS and Gaucho 70 WS following seed treatment in the field on sugar beet in Italy, DACO: 7.4.1                                               |
| 2031570              | 1990, NTN 33893; 100 AI; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                      |
| 2031571              | 1990, NTN 33893; 100 AI; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                      |
| 2031572              | 1990, NTN 33893; 100 AI; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                      |
| 2031573              | 1990, NTN 33893; 25 WP; apple; Germany; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031574              | 1990, NTN 33893; 100 AI; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                      |
| 2031575              | 1992, NTN 33893; 350 SC; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                      |
| 2031576              | 1990, NTN 33893; 100 AI; sugar beet; Great Britain; BBA, DACO: 7.4.1                                                                                                                      |
| 2031577              | 1990, NTN 33893; 100 AI; sugar beet; Germany; BBA, DACO: 7.4.1                                                                                                                            |
| 2031579              | 1990, NTN 33893 & D 1221; 5 GR; sugar beet; Germany; BBA, DACO: 7.4.1                                                                                                                     |
| 2031580              | 1992, Determination of residues of Confidor forte 5.0 GR (D 1221 & NTN 33893 or carbofuran & imidacloprid) in/on sugar beet under actual use conditions in Spain, DACO: 7.4.1             |
| 2031581              | 2008, Gaucho 75 WP - Determination of imidacloprid residues in processed sugar beet fractions, DACO: 7.4.1, 7.4.5                                                                         |
| 2031582              | 2002, Imidacloprid: Magnitude of the residue on beet (garden), DACO: 7.4.1                                                                                                                |
| 2031583              | 2001, Imidacloprid: Magnitude of the residue on carrot, DACO: 7.4.1                                                                                                                       |
| 2031584              | 2002, Imidacloprid: Magnitude of the residue on radish, DACO: 7.4.1                                                                                                                       |
| 2031585              | 1990, NTN 33893; 25 WP; apple; Germany; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031586              | 1998, Determination of residues of Gaucho (70 WS) in onion in the field in the Federal Republic of Germany, Great Britain and France, DACO: 7.4.1                                         |
| 2031587              | 1999, Determination of residues of Gaucho 70 WS on onion following seed treatment in the field in Germany, Benelux and Great Britain, DACO: 7.4.1                                         |
| 2031588              | 2008, Admire Pro 550 SC - Magnitude of the residue in/on bulb vegetables (Crop Group 3), DACO: 7.4.1                                                                                      |
| 2031590              | 2000, Imidacloprid: Residue levels found in above-ground vegetative plant parts following recommended application dosages, methods and timings to florida tomtato, DACO: 7.4.1            |
| 2031591              | 1996, Estudio de residuos de agrotoxicos, DACO: 7.4.1                                                                                                                                     |
| 2031592              | 2008, Determination of residues of Confidor 200 SL in/on aubergines following spray application and in/on cucumbers following drip irrigation application in Italy and Spain, DACO: 7.4.1 |
| 2031593              | 1993, Determination of residues of Confidor 200 SL in/on aubergine under actual use conditions in France, DACO: 7.4.1                                                                     |

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| 2031594              | 1997, Determination of residues of imidacloprid on aubergines in Italy after application of Confidor 200 SL (Greenhouse Experiments), DACO: 7.4.1                                                     |
| 2031595              | 2000, Determination of residues of imidacloprid on pepper after application of Confidor 200 SL in the greenhouse in Italy and Portugal, DACO: 7.4.1                                                   |
| 2031596              | 2004, Imidacloprid: Magnitude of the residue on basil, DACO: 7.4.1                                                                                                                                    |
| 2031597              | 1990, NTN 33893; 25 WP; apple; Germany; BBA, DACO: 7.4.1                                                                                                                                              |
| 2031598              | 1998, Determination of residues of imidacloprid in/on white cabbage after application of a Confidor 200 SL formulation in the field in France, DACO: 7.4.1                                            |
| 2031599              | 1995, Residues of imidacloprid in cabbages, DACO: 7.4.1                                                                                                                                               |
| 2031600              | 1997, Determination of residues of confidor 5 GR in mushrooms following compost-incorporation in great britain, DACO: 7.4.1                                                                           |
| 2031601              | 1992, NTN 33893; 200 SL; cotton; Greece; BBA, DACO: 7.4.1                                                                                                                                             |
| 2031602              | 1992, Imidacloprid (2.5GR & 240FS) - Magnitude of the residue on processed cotton commodities, DACO: 7.4.1,7.4.5                                                                                      |
| 2031603              | 1999, Contract trial to determine residues of imidacloprid in tea tree oil following four applications of Confidor 200 SC with Pulse penetrant as a high volume spray. Mareeba, Qld 1999, DACO: 7.4.1 |
| 2031604              | 1990, NTN 33893; 25 WP; apple; Germany; BBA, DACO: 7.4.1                                                                                                                                              |
| 2031605              | 1995, Addendum 1 - Imidacloprid (240 FS) - Magnitude of the residue on wheat processed commodities - Additional analytical data, DACO: 7.4.1,7.4.5                                                    |
| 2031606              | 1994, Determination of imidacloprid residues in wheat forage, straw and heads, DACO: 7.4.1                                                                                                            |
| 2031607              | 1994, Determination of imidacloprid residues in wheat forage, straw and grain, DACO: 7.4.1                                                                                                            |
| 2031608              | 1994, Determination of imidacloprid residues in wheat plant, straw and grain, DACO: 7.4.1                                                                                                             |
| 2031609              | 2001, Trials on the residue behaviour of Gaucho in cereals after seed treatment, DACO: 7.4.1                                                                                                          |
| 2031610              | 1993, Determination of residues of Gaucho 350 FS in/on spring barley and spring wheat under actual use conditions in the Federal Republic of Germany, DACO: 7.4.1                                     |
| 2031611              | 1992, NTN 33893; 350 FS; winter wheat; BBA, DACO: 7.4.1                                                                                                                                               |
| 2031612              | 1992, NTN 33893; 350 FS; winter wheat; BBA, DACO: 7.4.1                                                                                                                                               |
| 2031613              | 1995, Imidacloprid (240 FS)- Magnitude of the residues on seed treated wheat (seeding rate), DACO: 7.4.1                                                                                              |
| 2031614              | 1996, Determination of imidacloprid residues in wheat foliage, grain and straw, DACO: 7.4.1                                                                                                           |

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| 2031615              | 1990, NTN 33893; 25 WP; apple; Germany; BBA, DACO: 7.4.1                                                                        |
| 2031616              | 1995, Determination of imidacloprid residues in wheat foliage, DACO: 7.4.1                                                      |
| 2031617              | 1992, NTN 33893; 350 FS; winter wheat; Great Britain; BBA, DACO: 7.4.1                                                          |
| 2031618              | 2001, NTN 33893; 70 WS; winter wheat; France; BBA, DACO: 7.4.1                                                                  |
| 2031619              | 1992, NTN 33893; 70 WS; winter wheat; France; BBA, DACO: 7.4.1                                                                  |
| 2031620              | 2009, Magnitude of residues in/on wheat treated with a seed treatment application of the insecticide Gaucho 480 FL, DACO: 7.4.1 |
| 2031621              | 1995, Imidacloprid (240 FS)- Magnitude of the residues on seed treated barley, DACO: 7.4.1                                      |
| 2031622              | 1996, Determination of imidacloprid residues in barley foliage, DACO: 7.4.1                                                     |
| 2031623              | 1991, Determination of imidacloprid residues in barley samples, DACO: 7.4.1                                                     |
| 2031624              | 1994, Determination of imidacloprid residues in barley forage, straw and grain, DACO: 7.4.1                                     |
| 2031625              | 1990, NTN 33893; 70 WS; winter barley; France; BBA, DACO: 7.4.1                                                                 |
| 2031626              | 1995, Determination of residues of Confidor 200 SL in/on apple following spray application in Italy, DACO: 7.4.1                |
| 2031627              | 1992, NTN 33893; 350 FS; winter barley; France; BBA, DACO: 7.4.1                                                                |
| 2031628              | 1992, NTN 33893; 70 WS; winter barley; France; BBA, DACO: 7.4.1                                                                 |
| 2031629              | 1992, NTN 33893; 350 FS; winter barley; France; BBA, DACO: 7.4.1                                                                |
| 2031630              | 1995, Determination of imidacloprid residues in barley foliage, DACO: 7.4.1                                                     |
| 2031631              | 1994, Determination of imidacloprid residues in barley forage, straw and heads, DACO: 7.4.1                                     |
| 2031632              | 1990, NTN 33893; 70 WS; winter barley; Great Britain; BBA, DACO: 7.4.1                                                          |
| 2031633              | 1990, NTN 33893; 70 WS; winter barley; Great Britain; BBA, DACO: 7.4.1                                                          |
| 2031634              | 1992, NTN 33893; 350 FS; winter barley; Great Britain; BBA, DACO: 7.4.1                                                         |
| 2031635              | 1990, NTN 33893; 70 WS; winter barley; France; BBA, DACO: 7.4.1                                                                 |
| 2031636              | 1990, NTN 33893; 70 WS; winter barley; France; BBA, DACO: 7.4.1                                                                 |
| 2031637              | 1990, NTN 33893; 25 WP; apple; Germany; BBA, DACO: 7.4.1                                                                        |
| 2031638              | 1992, NTN 33893; 70 WS; winter barley; France; BBA, DACO: 7.4.1                                                                 |
| 2031639              | 1992, NTN 33893; 350 FS; winter barley; Great Britain; BBA, DACO: 7.4.1                                                         |
| 2031640              | 1995, Determination of imidacloprid residues in winter barley, DACO: 7.4.1                                                      |



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| 2031641              | 1987, Residue of NTN 33893 in harvested grains of winter barley after seed treatment with NTN 33893 70 WS, DACO: 7.4.1                                                                  |
| 2031642              | 1990, NTN 33893; 70 WS; winter barley; France; BBA, DACO: 7.4.1                                                                                                                         |
| 2031643              | 1992, NTN 33893; 350 FS; oat; Sweden; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031644              | 1992, NTN 33893; 350 FS; oat; Sweden; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031645              | 1994, Determination of imidacloprid residues in oat forage, straw and heads, DACO: 7.4.1                                                                                                |
| 2031646              | 1995, Determination of residues of Confidor TM 530 SL in/on tobacco following spray application in Greece, DACO: 7.4.1                                                                  |
| 2031647              | 1990, NTN 33893; 5 GR; corn; South Africa; BBA, DACO: 7.4.1                                                                                                                             |
| 2031648              | 1994, Determination of residues of Confidor 70 WG in apples under field conditions at 4 different locations on Germany, DACO: 7.4.1                                                     |
| 2031649              | 2001, NTN 33893; 350 FS; corn; France; BBA, DACO: 7.4.1                                                                                                                                 |
| 2031650              | 1995, Determination of imidacloprid residues in maize, DACO: 7.4.1                                                                                                                      |
| 2031651              | 1996, Determination of residues of Gaucho 600 FS in/on corn following seed dressing application in the Federal Republic of Germany, DACO: 7.4.1                                         |
| 2031652              | 1999, Determination of residues of Gaucho 350 FS and Gaucho 600 FS on corn following seed treatment in the field in Italy, DACO: 7.4.1                                                  |
| 2031653              | 1999, Determination of residues of Gaucho 350 FS and Gaucho 600 FS on corn following seed treatment in the field in Italy, DACO: 7.4.1                                                  |
| 2031654              | 1992, NTN 33893; 70 WS; corn; Spain; BBA, DACO: 7.4.1                                                                                                                                   |
| 2031655              | 1992, NTN 33893; 70 WS; corn; Spain; BBA, DACO: 7.4.1                                                                                                                                   |
| 2031656              | 1990, NTN 33893; 5 GR; maize; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031657              | 1990, NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                                   |
| 2031658              | 1992, NTN 33893; 70 WS; corn; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031659              | 1999, Determination of imidacloprid residues in apple fruit and pomace following one and two annual applications of Confidor 350 SC applied as soil drenches at petal fall, DACO: 7.4.1 |
| 2031660              | 1992, NTN 33893; 350 FS; corn; France; BBA, DACO: 7.4.1                                                                                                                                 |
| 2031661              | 2001, NTN 33893; 70 WS; corn; France; BBA, DACO: 7.4.1                                                                                                                                  |
| 2031662              | 2001, NTN 33893; 350 FS; corn; France; BBA, DACO: 7.4.1                                                                                                                                 |
| 2031663              | 1990, NTN 33893; 70 WS; maize; France; BBA, DACO: 7.4.1                                                                                                                                 |
| 2031664              | 1990, NTN 33893; 70 WS; maize; France; BBA, DACO: 7.4.1                                                                                                                                 |
| 2031665              | 1990, NTN 33893; 70 WS; corn; South Africa; BBA, DACO: 7.4.1                                                                                                                            |
| 2031666              | 1990, NTN 33893; 70 WS; maize; Germany; BBA, DACO: 7.4.1                                                                                                                                |
| 2031667              | 1990, NTN 33893; 70 WS; maize; Germany; BBA, DACO: 7.4.1                                                                                                                                |
| 2031668              | 1992, D 1221 & NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                          |
| 2031669              | 1992, D 1221 & NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                          |
| 2031670              | 1996, Determination of imidacloprid residues in apples, DACO: 7.4.1                                                                                                                     |

| PMRA Document Number | Reference                                                                                                                                                                                                                                                        |
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| 2031671              | 1992, D 1221 & NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                                                                                                   |
| 2031672              | 1992, D 1221 & NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                                                                                                   |
| 2031673              | 1992, D 1221 & NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                                                                                                   |
| 2031674              | 1992, D 1221 & NTN 33893; 5 GR; corn; France; BBA, DACO: 7.4.1                                                                                                                                                                                                   |
| 2031675              | 1996, Gaucho 480 FS - Determination of residues of imidacloprid in sorghum, DACO: 7.4.1                                                                                                                                                                          |
| 2031676              | 1995, Determination of imidacloprid residues in sorghum, DACO: 7.4.1                                                                                                                                                                                             |
| 2031677              | 1995, Determination of imidacloprid residues in lupins, DACO: 7.4.1                                                                                                                                                                                              |
| 2031678              | 2002, Determination of residues of Imidacloprid in/on alfalfa after spray application of Confidor 200 SL in the field in Spain, DACO: 7.4.1                                                                                                                      |
| 2031679              | 2001, Determination of residues of imidacloprid on alfalfa after spray application of Confidor 200 SL in the field in Italy and Spain, DACO: 7.4.1                                                                                                               |
| 2031680              | 2000, Determination of residues of imidacloprid in sugar cane and sugar cane tops after soil application of Confidor 050 GR and Confidor 200 SC to plant cycle sugar cane cv Q 124, DACO: 7.4.1                                                                  |
| 2031681              | 1999, Determination of imidacloprid residues in apple fruit and pomace following one and two annual applications of Confidor 350 SC applied as soil drenches at petal fall, DACO: 7.4.1                                                                          |
| 2031682              | 1998, Contract trial conducted by the bureau of sugar experiment stations for determination of residues of imidacloprid in sugar cane 147 days after banded subsurface soil application of Confidor 350 SC. Bundaberg, QLD. 1997., DACO: 7.4.1                   |
| 2031683              | 1998, Contract trial conducted by bureau of sugar experiment stations for determination of residues of imidacloprid in sugar cane 142 days after subsurface banded soil application of Confidor 350 SC. Ogden via Home Hill, Burdekin, Queensland., DACO: 7.4.1  |
| 2031684              | 1998, Contract trial conducted by bureau of sugar experiment stations for determination of residues of imidacloprid in ratoon sugar cane cv Q 138 at 159 days after subsurface banded soil application of Confidor 350 SC. Tully, North Queensland., DACO: 7.4.1 |
| 2031685              | 1998, To determine the level of residues of imidacloprid in sugar cane following one application of Confidor 350 SC using coulter either side of the cane stool. Bundaberg, QLD, 1997/1998., DACO: 7.4.1                                                         |
| 2031686              | 2000, Determination of residues of imidacloprid in sugar cane and sugar cane tops after soil application of Confidor 200 SC to ratoon sugar cane cv Q124. Giru, Qld. 1999/2000, DACO: 7.4.1                                                                      |
| 2031687              | 2000, Determination of residues of imidacloprid in second ratoon sugar cane cv. Q155 following one application of Confidor 200 SC using coulter either side of the cane stool. Bundaberg, QLD. 1999/2000, DACO: 7.4.1                                            |

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| 2031688              | 2000, Determination of residues of imidacloprid in sugar cane and sugar cane tops after soil application of Confidor 200 SC to ratoon sugar cane cv Q165. Home Hill, Qld. 1999/2000, DACO: 7.4.1                         |
| 2031689              | 1999, To determine the level of residues of imidacloprid in sugar cane cv. CP44-101 tops and billets following one application of Confidor 050 GR hand spread over the cane stool. Murwillumbah, NSW, 1999., DACO: 7.4.1 |
| 2031690              | 1999, To determine the level of residues of imidacloprid in sugar cane following one application of Confidor 050 GR using coulters either side of the cane stool, DACO: 7.4.1                                            |
| 2031691              | 1995, Determination of imidacloprid residues in sugar beets, DACO: 7.4.1                                                                                                                                                 |
| 2031692              | 1998, Determination of residues of Confidor (200 SC) on apple in the field in Italy, France and Spain, DACO: 7.4.1                                                                                                       |
| 2031693              | 1994, Metabolism of NTN 33893 in tobacco, DACO: 7.4.1                                                                                                                                                                    |
| 2031694              | 1999, Determination of residues of NTN 33893 & SRA 3886 246 CS in/on tobacco in the field in Italy, DACO: 7.4.1                                                                                                          |
| 2031695              | 1996, Determination of residues of Confidor 200 SL in/on tobacco following application by spraying or irrigation in Italy, DACO: 7.4.1                                                                                   |
| 2031696              | 2004, Determination of the residues of imidacloprid in/on sugar beet after seed treatment of Gaucho (600 FS) in the field in Spain, Italy and Southern France, DACO: 7.4.1                                               |
| 2031697              | 1992, Imidacloprid (240 FS) - Magnitude of the residue on tobacco, DACO: 7.4.1                                                                                                                                           |
| 2031698              | 1997, Admire 240 F- Magnitude of the residue on tobacco (Canada), DACO: 7.4.1                                                                                                                                            |
| 2031699              | 1996, Residue of imidacloprid in tobacco leaves (short report), DACO: 7.4.1                                                                                                                                              |
| 2031700              | 1995, Determination of residues of Confidor 200 SL in/on tobacco following spray application in Italy, DACO: 7.4.1                                                                                                       |
| 2031701              | 1995, Determination of residues of Confidor TM 530 SL in/on tobacco following spray application in Greece, DACO: 7.4.1                                                                                                   |
| 2031702              | 1993, Determination of residues of Confidor 200 SL in/on tobacco under actual use conditions in Italy, DACO: 7.4.1                                                                                                       |
| 2031703              | 1996, Determination of imidacloprid residues in apples, DACO: 7.4.1                                                                                                                                                      |
| 2031704              | 1993, Determination of residues of Confidor 200 SL in/on tobacco under actual use conditions in Spain, DACO: 7.4.1                                                                                                       |
| 2031705              | 1997, Determination of residues on tobacco after treatment with a Confidor TM 530 SL formulation in Italy, DACO: 7.4.1                                                                                                   |
| 2031706              | 1997, Determination of residues of imidacloprid on tobacco after treatment with Confidor 200 SL in Greece, DACO: 7.4.1                                                                                                   |

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| 2031707              | 1993, Imidacloprid (2F) - Magnitude of the residue on processed tomato commodities, DACO: 7.4.1,7.4.5                                                                                                 |
| 2031708              | 1996, Determination of residues of imidacloprid in peppers (sweet/bell and hot), DACO: 7.4.1                                                                                                          |
| 2031710              | 1993, Determination of residues of Confidor 200 SL in/on peppers under actual use conditions in Italy, DACO: 7.4.1                                                                                    |
| 2031711              | 1992, Determination of residues of Confidor 200 SL in/on paprika under actual use conditions in Spain, DACO: 7.4.1                                                                                    |
| 2031712              | 1997, Determination of residues of Confidor on paprika after application of a 200 SL formulation in Italy (Greenhouse experiments), DACO: 7.4.1                                                       |
| 2031713              | 1995, Determination of imidacloprid residues in cucurbits, DACO: 7.4.1                                                                                                                                |
| 2031714              | 1995, Determination of imidacloprid residues in cucurbits, DACO: 7.4.1                                                                                                                                |
| 2031715              | 1998, Determination of imidacloprid residues in apples, DACO: 7.4.1                                                                                                                                   |
| 2031716              | 1996, Residue of imidacloprid in pimento, DACO: 7.4.1                                                                                                                                                 |
| 2031718              | 2008, Determination of residues of Admire 70 WG following drip irrigation application to peppers in the Netherlands, DACO: 7.4.1                                                                      |
| 2031719              | 1994, Determination of imidacloprid residues in cucumber, DACO: 7.4.1                                                                                                                                 |
| 2031720              | 1996, Determination of residues of Confidor 200 SL in cucumbers following drip irrigation application in France (greenhouse), DACO: 7.4.1                                                             |
| 2031721              | 1996, Determination of residues of Confidor 200 SL in cucumber and zucchinis following spray application in Italy (greenhouse), DACO: 7.4.1                                                           |
| 2031722              | 1998, Determination of residues of Confidor 70 WG in cucumber following stem application in the greenhouse in Germany, DACO: 7.4.1                                                                    |
| 2031723              | 1995, Determination of residues of NTN 33893 70 WG following drip irrigation application and NTN 33893 0.125 PR following stick application in cucumber in the Netherlands, DACO: 7.4.1               |
| 2031724              | 1997, Determination of residues of Admire 70 WG in cucumbers following drip irrigation application in the Netherlands, DACO: 7.4.1                                                                    |
| 2031725              | 1996, Imidacloprid (NTN 33893) : Magnitude of the residue in/on cucumber - 1992, DACO: 7.4.1                                                                                                          |
| 2031727              | 1994, Determination of imidacloprid residues in zucchinis, DACO: 7.4.1                                                                                                                                |
| 2031728              | 1998, Determination of imidacloprid residues in apples, DACO: 7.4.1                                                                                                                                   |
| 2031729              | 2002, Determination of residues of imidacloprid in/on cucumber following spray application of Confidor Forte 200 SL in the greenhouse in Spain, Northern France and Germany, DACO: 7.4.1              |
| 2031732              | 1993, Determination of residues of Confidor 200 SL in/on cucumber under actual use conditions in France, DACO: 7.4.1                                                                                  |
| 2031733              | 2002, Determination of residues of imidacloprid in/on cucumber after spray application of Confidor forte 200 SL in the greenhouse in Belgium, the Netherlands, Germany, Italy and Greece, DACO: 7.4.1 |



| PMRA Document Number | Reference                                                                                                                                                                   |
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| 2031734              | 2002, Determination of residues of imidacloprid in/on cucumber after spray application of Confidor Forte 200 SL in the greenhouse in Spain, Greece and Germany, DACO: 7.4.1 |
| 2031735              | 1996, Imidacloprid (NTN 33893) : Magnitude of the residue in/on squash (summer) - 1992, DACO: 7.4.1                                                                         |
| 2031737              | 1996, Imidacloprid (NTN 33893) : Magnitude of the residue in/on cucumbers - 1992, DACO: 7.4.1                                                                               |
| 2031738              | 1996, Imidacloprid (NTN 33893) : Magnitude of the residue in/on squash (summer) - 1993, DACO: 7.4.1                                                                         |
| 2031739              | 1996, Determination of imidacloprid residues in cucurbits, DACO: 7.4.1                                                                                                      |
| 2031740              | 1998, Residues of imidacloprid in sweet corn, DACO: 7.4.1                                                                                                                   |
| 2031741              | 1995, Residues of imidacloprid in sweet corn, DACO: 7.4.1                                                                                                                   |
| 2031742              | 1998, Determination of imidacloprid residues in apples, DACO: 7.4.1                                                                                                         |
| 2031743              | 1996, Determination of imidacloprid residues in apples, DACO: 7.4.1                                                                                                         |
| 2031745              | 1996, Residues of imidacloprid in apples, DACO: 7.4.1                                                                                                                       |
| 2031746              | 1996, Residues of imidacloprid in apples, DACO: 7.4.1                                                                                                                       |
| 2031747              | 1996, Determination of Confidor 350 SC residues in cv. Granny Smith apples following a soil drench application, DACO: 7.4.1                                                 |
| 2031748              | 1995, Admire 240FS- Magnitude of the residues in apples, DACO: 7.4.1                                                                                                        |
| 2031750              | 1996, Determination of residues of Confidor 200 SL in/on pear and apple under actual use conditions in Italy, DACO: 7.4.1                                                   |
| 2031751              | 1993, Determination of residues of Confidor 70 WG in/on apple under actual use conditions in the Federal Republic of Germany, DACO: 7.4.1                                   |
| 2031752              | 1992, Imidacloprid (240FS)- Magnitude of the residue on apples, DACO: 7.4.1                                                                                                 |
| 2031753              | 1992, Trials concerning the residue behaviour of Confidor in apples, DACO: 7.4.1                                                                                            |
| 2031755              | 2000, Determination of residues of imidacloprid on apple and pear after spray application of Confidor & Oliocin 804 SE in the field in Italy, DACO: 7.4.1                   |
| 2031756              | 1992, Imidacloprid (240FS) - Magnitude of the residue on apple, DACO: 7.4.1                                                                                                 |
| 2031758              | 2003, Determination of residues of Imidacloprid in/on apple following one spray application of Confidor Oil 004 SC in the field in Greece, DACO: 7.4.1                      |
| 2031759              | 1992, Imidacloprid (240FS) - Magnitude of the residue on processed apple commodities, DACO: 7.4.1, 7.4.5                                                                    |
| 2031763              | 1995, Admire 2 F- Magnitude of the residue on field treated pears, DACO: 7.4.1                                                                                              |
| 2031765              | 1997, Admire 240 FS- Magnitude of the residue on pears (Canada), DACO: 7.4.1                                                                                                |

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| 2031768              | 1992, NTN 33893; 70 WG; pear; France; BBA, DACO: 7.4.1                                                                                             |
| 2031770              | 1992, NTN 33893; 70 WG; pear; France; BBA, DACO: 7.4.1                                                                                             |
| 2031773              | 2000, Determination of residues of imidacloprid on pear after spray application of Confidor 200 SL in the field in Greece, DACO: 7.4.1             |
| 2031774              | 1990, NTN 33893; 200 SL; pear; Spain; BBA, DACO: 7.4.1                                                                                             |
| 2031775              | 2005, Imidacloprid: Magnitude of the residue on pomegranate, DACO: 7.4.1                                                                           |
| 2031777              | 2000, Determination of residues of imidacloprid on peach after spray application of Confidor & Oliocin 804 SE in the field in Italy, DACO: 7.4.1   |
| 2031778              | 1994, Determination of residues of Confidor 200 SL in/on nectarine, peach, plum and sweet cherry under actual use conditions in Italy, DACO: 7.4.1 |
| 2031780              | 1993, Determination of residues of Confidor 200 SL in/on nectarine under actual use conditions in Italy, DACO: 7.4.1                               |
| 2031781              | 2001, Determination of residues of Confidor 200 SL on nectarine following spray application in Italy, DACO: 7.4.1                                  |
| 2031782              | 1996, Determination of residues of Confidor 200 SL in/on peach following spray application in Italy, DACO: 7.4.1                                   |
| 2031783              | 1997, Determination of residues of Confidor (200 SC) on peach in France, Italy and Spain, DACO: 7.4.1                                              |
| 2031784              | 1992, NTN 33893; 200 SL; peach; France; BBA, DACO: 7.4.1                                                                                           |
| 2031785              | 2001, Determination of residues of Confidor 200 SL in/on peach under actual use conditions in Spain, DACO: 7.4.1                                   |
| 2031786              | 1993, Determination of residues of Confidor 200 SL in/on peach under actual use conditions in Spain, DACO: 7.4.1                                   |
| 2031787              | 1992, NTN 33893; 200 SL; peach; Greece; BBA, DACO: 7.4.1                                                                                           |
| 2031788              | 1992, NTN 33893; 70 WG; peach; France; BBA, DACO: 7.4.1                                                                                            |
| 2031789              | 1992, NTN 33893; 70 WG; peach; France; BBA, DACO: 7.4.1                                                                                            |
| 2031791              | 1992, NTN 33893; 70 WG; peach; France; BBA, DACO: 7.4.1                                                                                            |
| 2031792              | 1992, NTN 33893; 200 SL; peach; France; BBA, DACO: 7.4.1                                                                                           |
| 2031793              | 1992, NTN 33893; 70 WG; peach; France; BBA, DACO: 7.4.1                                                                                            |
| 2031794              | 1992, NTN 33893; 200 SL; peach; Spain; BBA, DACO: 7.4.1, 7.4.5                                                                                     |
| 2031795              | 1992, NTN 33893; 70 WG; peach; France; BBA, DACO: 7.4.1                                                                                            |
| 2031796              | 1992, NTN 33893; 200 SL; peach; Spain; BBA, DACO: 7.4.1                                                                                            |
| 2031797              | 1992, NTN 33893; 70 WG; peach; France; BBA, DACO: 7.4.1                                                                                            |
| 2031798              | 2000, Provado 1.6F - Magnitude of the residue on peaches, DACO: 7.4.1                                                                              |

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| 2031799              | 2002, Determination of residues of imidacloprid in/on peach (peel; fruit, washed; preserve; washing water; fruit, stoned; fruit, peeled) following spray application of Confidor Forte SL 200 in the field in Italy, Spain and Southern France, DACO: 7.4.1,7.4.5 |
| 2031803              | 2002, Imidacloprid: Magnitude of the residue on peach, DACO: 7.4.1                                                                                                                                                                                                |
| 2031805              | 2002, Determination of residues of imidacloprid in/on peach following spray application of Confidor Forte SL 200 in the field in Italy, Spain, Southern France and Portugal, DACO: 7.4.1                                                                          |
| 2031806              | 1996, Determination of residues of imidacloprid and methamidophos after application of Confidor TM 530 SL on peach and nectarine in France and Italy, DACO: 7.4.1                                                                                                 |
| 2031808              | 1996, Determination of residues of Confidor TM 530 SL on peach following spray application in France, DACO: 7.4.1                                                                                                                                                 |
| 2031809              | 2002, Determination of residues of imidacloprid in peaches following one application of Confidor-oil 804 SE (004 SC) insecticide Greece - 2001, DACO: 7.4.1                                                                                                       |
| 2031811              | 1995, Determination of residues of Confidor 200 SL on sweet cherry and plum following spray application in Italy, DACO: 7.4.1                                                                                                                                     |
| 2031814              | 1999, Determination of residues of Confidor 70 WG on cherry following spray application in the field in Germany, Benelux and France, DACO: 7.4.1                                                                                                                  |
| 2031816              | 2000, Determination of residues of Confidor 200 SL [a.s. imidacloprid] on sweet cherry following spray application in the field in Spain, DACO: 7.4.1                                                                                                             |
| 2031817              | 1993, Determination of residues of Confidor 200 SL in/on cherry under actual use conditions in Italy, DACO: 7.4.1                                                                                                                                                 |
| 2031818              | 1992, [Pyridinyl-14C-methyl] NTN 33893 residues in rotational crops, DACO: 7.4.4,7.4.5                                                                                                                                                                            |
| 2031822              | 1994, Admire ( 2.5 Granular) - Residues in field rotational crops, DACO: 7.4.4                                                                                                                                                                                    |
| 2031826              | 1999, Admire 2F - Magnitude of the residue in field rotational crops forage grass, alfalfa, and peanuts. Addendum 2, DACO: 7.4.4                                                                                                                                  |
| 2031829              | 1996, Residues of imidacloprid in the rotational crops of peas and beans following imidacloprid-treated potatoes (Canada), DACO: 7.4.4                                                                                                                            |
| 2031830              | 1994, Admire 2 F - Magnitude of the residue on tomato processed commodities, DACO: 7.4.5                                                                                                                                                                          |
| 2031833              | 2007, TRIMAX 4F - Magnitude of the residue on soybean processed commodities and aspirated grain fractions, DACO: 7.4.5                                                                                                                                            |
| 2031835              | 2004, Determination of residues of imidacloprid in processed fractions of soybean, DACO: 7.4.5                                                                                                                                                                    |

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| 2031836              | 2007, Magnitude of residues in/on soybeans treated with three applications of the insecticide concept 850D with a 20 day PHI, DACO: 7.4.5 |
| 2031838              | 1995, Determination of imidacloprid residue in processed rapeseed fractions, DACO: 7.4.5                                                  |
| 2031841              | 1994, Determination of imidacloprid residues in canola forage, straw & seeds, DACO: 7.4.5                                                 |
| 2031842              | 1991, Results of the hop processing study R001856 based on total imidacloprid residues, DACO: 7.4.5                                       |
| 2031843              | 1992, Imidacloprid (240FS & 2.5GR) - Magnitude of the residue on processed potato commodities, DACO: 7.4.5                                |
| 2031844              | 1996, Gaucho 480 FS - Determination of residues of imidacloprid in processed corn fractions, DACO: 7.4.5                                  |
| 2031849              | 1994, Determination of imidacloprid residues in lupin grain and straw, DACO: 7.4.5                                                        |
| 2031850              | 1994, Determination of imidacloprid residues in triticale forage, straw and heads, DACO: 7.4.5                                            |
| 2031852              | 1996, Admire 2F - Magnitude of the residue in field rotational crops, DACO: 7.4.5                                                         |
| 2031857              | 1999, Admire 2F - Magnitude of the residue in rotational crops. Additional field corn grain data. Addendum 1, DACO: 7.4.5                 |
| 2031861              | 1994, NTN 33893 - Poultry feeding study, DACO: 7.5                                                                                        |
| 2031865              | 1994, NTN 33893 - Cattle feeding study, DACO: 7.5                                                                                         |
| 2142712              | Sur, R.; Stork, A., 2003, Uptake, translocation and metabolism of imidacloprid in plants, DACO: 6.3,8.6                                   |
| 2523494              | 1997, Photolysis of imidacloprid (NTN 33893) on leaf surfaces of tomato plants, DACO: 6.3,8.6                                             |

### A.2.3 Occupational and Non-occupational Assessment

| PMRA Document Number | Reference                                                                                                                                                                                                                                                                      |
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| 1191375              | On Farm Operator Exposure Study With Dividend 36 FS Seed Treatment On Wheat, J.R. Purdy, April 15, 1998 To October 10, 1998 (CER05314/98) [Dividend 36FS Fungicide Agricultural; SUBN.#1999-0932; REGN.#25775; Submitted May 7, 1999; Volume 2 PART 5 Exposure], DACO: 5.3,5.4 |
| 1335563              | 2006, Gaucho 480 SC - Worker Exposure During On-farm and Commercial Seed Treatment of Cereals, DACO: 5.4                                                                                                                                                                       |



| PMRA Document Number | Reference                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| 1372835              | 2006, Admire 240F - Determination of Dermal and Inhalation Exposure of Workers during On-Farm Seed Piece Treatment of Potatoes, DACO: 5.4                                                                                                                                                                                                                                                                                                  |
| 1525896              | 2001, Determination of exposure to pencycuron during loading and application of Moncereen-Droogontsmetter (Monceren DS 12.5) in potato fields, DACO: 5.4,5.6                                                                                                                                                                                                                                                                               |
| 1563628              | 1999, Outdoor Residential Pesticide Use and Usage Survey and National Gardening Association Survey. Vol 1 of 2, DACO: 5.2                                                                                                                                                                                                                                                                                                                  |
| 1563634              | 1999, Outdoor Residential Pesticide Use and Usage Survey and National Gardening Association Survey. Vol 2 of 2, DACO: 5.2                                                                                                                                                                                                                                                                                                                  |
| 1563641              | 1999, Integrated Report for Evaluation of Potential Exposures to Homeowners and Professional Lawn Care Operators Mixing, Loading, and Applying Granular and Liquid Pesticides to Residential Lawns. APPENDIX 3 Exposure Of Professional Lawn Care Workers During The Mixing, Loading, And Application Of Granular Turf Pesticides Utilizing A Surrogate Compound., DACO: 5.3,5.4                                                           |
| 1563654              | 1999, Integrated Report for Evaluation of Potential Exposures to Homeowners and Professional Lawn Care Operators Mixing, Loading, and Applying Granular and Liquid Pesticides to Residential Lawns. APPENDIX 4 Exposure Of Professional Lawn Care Workers During The Mixing And Loading Of Dry And Liquid Formulations And The Liquid Application Of Turf Pesticides Utilizing A Surrogate Compound., DACO: 5.3,5.4                        |
| 1563664              | 1999, Integrated Report for Evaluation of Potential Exposures to Homeowners and Professional Lawn Care Operators Mixing, Loading, and Applying Granular and Liquid Pesticides to Residential Lawns. APPENDIX B Field Phase Report for Exposure of Professional Lawn Care Workers During the Mixing and Loading of Dry and Liquid Formulations and the Liquid Application of Turf Pesticides Utilizing a Surrogate Compound., DACO: 5.3,5.4 |
| 1563670              | 1999, Integrated Report for Evaluation of Potential Exposures to Homeowners and Professional Lawn Care Operators Mixing, Loading, and Applying Granular and Liquid Pesticides to Residential Lawns. APPENDIX 5 A Generic Evaluation Of Homeowner Exposure Associated With Granular Turf Pesticide Handling And Application To Residential Lawns, DACO: 5.3,5.4                                                                             |

| PMRA Document Number | Reference                                                                                                                                                                                                                                                                                                                                                                                               |
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| 2004944              | 2010, Agricultural Handler Exposure Scenario Monograph: Open Cab Airblast Application of Liquid Sprays, DACO: 5.3,5.4                                                                                                                                                                                                                                                                                   |
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### A.3.0 Environmental Assessment

#### A.3.1 Environmental Fate and Effects Assessment

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| PMRA Document Number | Reference                                                                                                                                                                                                                                                        |
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| 1155724              | NTN 33893 Study For Acute Oral Toxicity To Rats (100040;18594) (Imidacloprid/Admire), DACO: 4.2.1                                                                                                                                                                |
| 1155825              | Soil/Sediment Adsorption-Desorption Of 14C- Imidacloprid (103817;N3182102)(Admire), DACO: 8.2.4.1                                                                                                                                                                |
| 1155827              | Adsorption/Desorption Of NTN 33893 On Soils, R. Fritz, November 11, 1988 (99199;M 1310231/1) (Admire/Imidacloprid), DACO: 8.2.4.1                                                                                                                                |
| 1155829              | Photodegradation Of NTN 33893 On Soil (100249;NO. 88012/ESR) (Imidacloprid/Admire), DACO: 8.2.1                                                                                                                                                                  |
| 1155830              | Metabolism Of [Pyridinyl- 14-C-Methylene] NTN 33893 In Loamy Sand Soil Bba 2.2 Under Aerobic Conditions (100140;M 1250187-4) (Imidacloprid/Admire), DACO: 8.2.3.1                                                                                                |
| 1155832              | Degradation Of [Pyridinyl-14-C - Methylene] NTN 33893 In Silt Soil Hoefchen Under Aerobic Conditions (100141;M 1250187-4) (Imidacloprid/Admire), DACO: 8.2.3.1                                                                                                   |
| 1155834              | Photodegradation Of NTN 33893 In Water (88010;101956) (Imidacloprid/Admire), DACO: 8.2.1                                                                                                                                                                         |
| 1155835              | Terrestrial Field Dissipation For NTN 33893 In Minnesota Soil (101988;392723;N3022103) (Imidacloprid/Admire), DACO: 8.3.2.3                                                                                                                                      |
| 1155836              | Terrestrial Field Dissipation In Turf For NTN 33893 In Georgia (102603;393553) (Imidacloprid/Admire). Study Finalized: February 10, 1992. Submitting Laboratory: Miles Inc., Stillwell, Kansas. Authors: Fred Rice; Dave Schwab; Patrick Nowland., DACO: 8.3.2.3 |
| 1155837              | Terrestrial Field Dissipation For Ntn 33893 In California Soil (101989;392733;N3022102) (Imidacloprid/Admire), DACO: 8.3.2.3                                                                                                                                     |
| 1155838              | Metabolism Of [Pyridinyl-14-C-Methylene] NTN 33893 In Sandy Loam Under Anaerobic Conditions (101241;M 1250187-4) (Imidacloprid/Admire), DACO: 8.2.3.1                                                                                                            |

| PMRA Document Number | Reference                                                                                                                                                                           |
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| 1155840              | Hydrolysis Of NTN 33893 (99708;88011/ESR) (Imidacloprid/Admire), DACO: 8.2.1                                                                                                        |
| 1155842              | Technical NTN 33893: An Acute Oral LD50 With Bobwhite Quail (100059;N3711702)(Imidacloprid/Admire), DACO: 9.6.2.1                                                                   |
| 1155843              | Technical NTN 33893: Subacute Dietary LC50 With Bobwhite Quail (100241;N3721702) (Imidacloprid/Admire), DACO: 9.6.2.4                                                               |
| 1155844              | Technical NTN 33893: A Subacute Dietary Lc50 With Mallard Ducks (100238;N3720801) (Imidacloprid/Admire), DACO: 9.6.2.4                                                              |
| 1155846              | Technical NTN 33893: A One Generation Reproduction Study With Bobwhite Quail (101203;N3741701) (Imidacloprid/Admire), DACO: 9.6.3.1                                                 |
| 1155847              | Technical NTN 33893: A One Generation Reproduction Study With Mallard Ducks (101205;N3740801) (Imidacloprid/Admire), DACO: 9.6.3.1                                                  |
| 1155848              | 1992, Technical NTN 33893: A One Generation Reproduction Study With Mallard Ducks (103813;N3740802)(Imidacloprid/Admire). DACO: 9.6.3.1                                             |
| 1155850              | 1988, The Acute Toxicity of NTN 33893 Technical to Rainbow Trout ( <i>Salmo Gairdneri</i> ) in a Static Test (101303;E 2800098-7)(Imidacloprid/Admire). DACO : 9.5.2.1              |
| 1155851              | 1990, Acute Toxicity of NTN 33893 to Rainbow Trout (100349;Final Report #37861)(Imidacloprid/Admire). DACO: 9.5.2.1                                                                 |
| 1155853              | Leaching Behaviour Of NTN 33893 Aged In Soil (99635;M 1210225/3) (Imidacloprid/Admire), DACO: 8.2.4.1                                                                               |
| 1155854              | Acute Toxicity Of NTN 33893 To Bluegill (100348; Final Report #37860) (Imidacloprid/Admire), DACO: 9.5.2.1                                                                          |
| 1155855              | 1991, Early Life Stage Toxicity of NTN 33893 Technical to Rainbow Trout in a Flow-Through System (101214;38347)(Imidacloprid/Admire). DACO: 9.5.3.1                                 |
| 1155856              | 1990, NTN 33893 Technical: Acute Toxicity to Sheepshead Minnow ( <i>Cyprinodon Variegatus</i> ) Under Static Test Conditions (100354;J9008023E)(Imidacloprid/Admire). DACO: 9.5.2.1 |
| 1155858              | 1990, NTN -33893 Technical: Acute Toxicity to the Mysid <i>Mysidopsis bahia</i> Under Flow-Through Test Conditions (100355;J9008023B,F)(Imidacloprid/Admire). DACO: 9.4.1           |
| 1155859              | Acute Toxicity Of NTN 33893 To <i>Hyalella Azteca</i> (101960;39442) (Imidacloprid/Admire), DACO: 9.3.1                                                                             |
| 1155860              | 1992, NTN 33893 (240 Fs Formulation): Acute Toxicity to the Mysid <i>Mysidopsis bahia</i> Under Flow-Through Conditions (103845;J9202001)(Imidacloprid/Admire). DACO: 9.4.1         |



| PMRA Document Number | Reference                                                                                                                                                                                                                                                                                                                      |
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| 1155861              | Acute Toxicity Of NTN 33893 To Daphnia Magna (100245;37862) (Imidacloprid/Admire), DACO: 9.3.1                                                                                                                                                                                                                                 |
| 1155862              | 1991, NTN 33893 Technical Chronic Toxicity to the Mysid <i>Mysidopsis bahia</i> , Under Flow-Through Test Conditions (101347;J9008023G,H) (Imidacloprid/Admire), DACO: 9.4.1                                                                                                                                                   |
| 1155863              | Growth And Survival Of The Midge (Chironomus Tentans) Exposed To NTN 33893 Technical Under Static Renewal Conditions (101985;N3881401) (Imidacloprid/Admire), DACO: 9.3.1                                                                                                                                                      |
| 1155864              | Degradation Of [Pyridinyl-14-C- Methylene] NTN 33893 In Sandy Loam Monheim 1 Under Aerobic Conditions (101955;M 1250187-4) (Imidacloprid/Admire), DACO: 8.2.3.1                                                                                                                                                                |
| 1155865              | Degradation Of Pesticides Under Anaerobic Conditions In The System Water/Sediment: Imidacloprid, NTN 33893 (Admire) (101346;1520205-5), DACO: 8.2.3.1                                                                                                                                                                          |
| 1155868              | Dissipation Of Imidacloprid In Soil Under Field Conditions (103948;RA-2082/91) (Admire), DACO: 8.3.2.3                                                                                                                                                                                                                         |
| 1155869              | Terrestrial Field Dissipation In Turf For NTN 33893 In Minnesota (102604;393543) (Admire/Imidacloprid). Authors: Fed Rice; Dan Judy; Patrick Noland. Study Finalized: February 28, 1992. Submitting Laboratory: Miles Inc., Stilwell, Kansas. Analytical Laboratory: ABC Laboratories Inc., Columbia, Missouri., DACO: 8.3.2.3 |
| 1155870              | Terrestrial Field Dissipation For NTN 33893 In Georgia Soil (101987;392743;N3022101) (Admire/Imidacloprid), DACO: 8.3.2.3                                                                                                                                                                                                      |
| 1155875              | 21-Day Chronic Static Renewal Toxicity Of NTN 33893 To Daphnia Magna (100247;38346) (Imidacloprid/Admire), DACO: 9.3.1                                                                                                                                                                                                         |
| 1155896              | Assessment Of The Potential Ecological And Biological Effects Of NTN 33893 On Aquatic Ecosystems As Measured In Fiberglass Pond Systems (102600) (Imidacloprid/Admire), DACO: 9.5.3.1                                                                                                                                          |
| 1157921              | NTN 33893 2.5G: An Acute Oral LD50 With House Sparrows (Passer Domesticus)(N3711402;101324) (Admire), DACO: 9.6.2.1                                                                                                                                                                                                            |
| 1157922              | Bird Toxicity Oral/Pigeon (Columbia Livia) (GMU11194.DOC;106611;VT-113) (Admire), DACO: 9.6.2.1                                                                                                                                                                                                                                |

| PMRA Document Number | Reference                                                                                                                                                                                                                                         |
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| 1157923              | Bird Toxicity Oral/ Canary Bird ( <i>Serinus Canarius</i> ) (GMU10994.DOC;106610;VK-300) (Admire), DACO: 9.6.2.1                                                                                                                                  |
| 1157924              | Acute Oral LD50 Of NTN 33893 To Japanese Quail (VW-123;E2930082-4;106608)(Admire), DACO: 9.6.2.1                                                                                                                                                  |
| 1157925              | Subchronic Oral Toxicity Of NTN 33893 Techn. To Japanese Quails In A 5-Day Dietary Test (Preliminary Report) (106609;VB-837;PF-ZPM/NP;PF-E/OE;PF-E/REG) (Admire), DACO: 9.6.2.4                                                                   |
| 1157927              | 1991, Acute Toxicity of NTN 33893 Technical to the Green Alga ( <i>Selenastrum capricornutum</i> )(101986;N3881601)(Admire). DACO: 9.8.2                                                                                                          |
| 1157928              | 1989, Growth Inhibition of Green Algae ( <i>Scenedesmus subspicatus</i> ) Caused by NTN 33893 (Technical)(100098)(Admire). DACO: 9.8.2                                                                                                            |
| 1160858              | Degradation And Translocation Of Imidacloprid (NTN33893) Under Field Conditions On A Lysimeter.(M1330351-6;106426;106426-1) + Amendment To The Original Report.(Completion Dates February 22,1994 And March 16,1994) (Admire 240F), DACO: 8.2.4.1 |
| 1160913              | Acute Toxicity Of NTN 33893 (Techn.) To Earth Worms.(Admire 240F), DACO: 9.2.3.1                                                                                                                                                                  |
| 1166100              | Acute Toxicity Of 14C-NTN 33823 To <i>Hyalella Azteca</i> Under Static Conditions (N3823202;107315)(Admire 240), DACO: 9.3.5                                                                                                                      |
| 1166101              | Acute Toxicity Of 14C-NTN 33823 To <i>Chironmus Tentans</i> Under Static Conditions (N3823302;107316)(Admire 240), DACO: 9.3.5                                                                                                                    |
| 1166103              | Acute Toxicity Of 14C-NTN 33519 To <i>Hyalella Azteca</i> Under Static Conditions (N3823201;107148) (Admire 240), DACO: 9.3.5                                                                                                                     |
| 1167315              | Acute Toxicity Test Of 14C-NTN 33823 To <i>Chironomus Tentans</i> Under Static Conditions (107316;N3823302) (Admire 240), DACO: 9.3.4                                                                                                             |
| 1167316              | Acute Toxicity OF 14C-NTN 33823 To <i>Hyalella Azteca</i> Under Static Conditions (107315;N3823202)(Admire 240), DACO: 9.3.4                                                                                                                      |
| 1172514              | Changes In Sorption Of Imidacloprid With Incubation Time. L.Cox. Completion Date: January 20,1997.(107685;VER.12-19).(Admire 240F), DACO: 8.2.4.2                                                                                                 |

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| 1174607              | Terrestrial Field Dissipation Of Imidacloprid On Turf In Ontario, Canada, 1994. J.Philpot & P.Yen. Completion Date January 15, 1998. (ADMIRE 240FS), DACO: 8.3.2.1                                                                                                                             |
| 1174608              | Terrestrial Field Dissipation Of Imidacloprid On Bare Sandy Loam In Prince Edward Island, Canada, 1994. J.Philpot & P.Yen. Completion Date January 14, 1998. (Admire 240FS), DACO: 8.3.2.1                                                                                                     |
| 1174609              | Terrestrial Field Dissipation Of Imidacloprid On Bare Loam In Ontario, Canada, 1994. J.Philpot & P.Yen. Completion Date January 15, 1998. (Admire 240FS), DACO: 8.3.2.1                                                                                                                        |
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| 1181128              | Acute Toxicity Of 6-Chloronicotinic Acid (A Metabolite Of Imidacloprid) To Chironomus Tentans Under Static Renewal Conditions. L.Bowers & C.Lam. Completion Date: April 23, 1998. (108127; 96-B-123). [Admire 240; SUBN#96-2186; REGN#24094], DACO: 9.3.5                                      |
| 1182367              | 1996, Toxicity of NTN 33893 2F to the Freshwater Diatom <i>Navicula pelliculosa</i> (N3883401; 107658) [Admire 240; Regn.#24094]. DACO: 9.8.2                                                                                                                                                  |
| 1182368              | 1996, Toxicity of NTN 33893 2F to the Blue-Green Alga <i>Anabaena flos-Aquae</i> (N3831401; 107549) [Admire 240; Regn.#24094]. DACO: 9.8.2                                                                                                                                                     |
| 1182372              | 1995, Mineralization of [Imidazolidin-4,5-14C] NTN 33893 to $^{14}\text{CO}_2$ in Sterile and Microbiologically Active Samples of two Agricultural Soils (140095; 107300). DACO : 8.2.3.4.2                                                                                                    |
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| 1182374              | NTN 33893 Technical: An Acute Oral Ld50 With Mallards, G.A. Hancock, June 20, 1996 (107354; N3710802) [BAY NTN 33893; REGN.#24468], DACO: 9.6.2.2                                                                                                                                              |
| 1182985              | Acute Toxicity Of 6-Chloronicotinic Acid (A Metabolite Of Imidacloprid) To Chironomus Tentans Under Static Renewal Conditions, L.M. Bowers, C.V. Lam, Completed April 23, 1998 (96-B-123; 108127) [Admire 240; SUBN.#96-2186; REGN.#24094; SUBMITTED MAY 13, 1998; VOLUME 1 OF 1], DACO: 9.3.4 |

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| 1429590              | 1999, Terrestrial Plants, Growth Test With Imidacloprid, DACO: 9.8.4                                                                                                  |
| 1429593              | 2004, Non-target terrestrial plants: an evaluation of the effects of Imidacloprid SL 200 in the seedling emergence and growth test (Tier 1), DACO: 9.8.4              |
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| 1504639              | 2002, Acute Immobilisation Test with Imidacloprid Technical in <i>Daphnia magna</i> , DACO: 9.3.2                                                                     |
| 1504640              | 2002, Acute Toxicity of Imidacloprid Technical to Freshwater Fish, <i>Poecilia reticulata</i> (10125 05-036-2002). DACO: 9.5.2.1                                      |
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| 2030939              | 1991, NTN 33893 AMP (proposed c.n.: Imidacloprid) - Study for acute oral toxicity to rats, DACO: 4.2.1                                                                |
| 2030940              | 1991, NTN 33893 CNS (c.n.: Imidacloprid (proposed) - Study for acute oral toxicity in rats, DACO: 4.2.1                                                               |
| 2142713              | 1998, Influence of Soil Properties on Sorption-Desorption of Imidacloprid (M-023925-01-2). DACO : 8.2.4.2                                                             |
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| 2142715              | Cox, L.; Koskinen, W. C.; Yen, P. Y., 2009, Sorption-desorption of Imidacloprid and its metabolites in soils, DACO: 8.2.4.2                                           |
| 2142716              | Oi, M., 2009, Time-dependent sorption of imidacloprid in two different soils, DACO: 8.2.4.2                                                                           |
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| 2142729              | 2009, Biological effects and fate of imidacloprid SL 200 in outdoor microcosm ponds, DACO: 8.6                                                                                                       |
| 2142783              | 2009, Residues in Arthropod Prey of Birds and Mammals After the Application of Confidor SL 200 (Active Substance Imidacloprid) in a German Pome Fruit Orchard (M-000054-01-2; WFC/FS 008). DACO: 9.9 |
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| 2142816              | 2011, Aerobic metabolism of imidacloprid, <sup>14</sup> C-NTN 33893, in an aquatic model ecosystem, DACO: 8.2.3.5.4                                                                                  |
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| 2192430              | 2012, Amphibian Metamorphosis Assay With South African Clawed-Frog ( <i>Xenopus laevis</i> ) Exposed to Imidacloprid Technical Under Flow-Through Conditions (M-428255-01-1; EBNTY004). DACO: 9.9    |
| 2464657              | 1998, Long-term soil dissipation study with Confidor 70 WG in apple orchards in Germany following spray application, DACO: 8.3.2.3,8.3.4                                                             |
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| 2523498              | 1990, Leaching Behaviour of Pesticide; Active Ingredient; Gaucho 70 WS; Standard Soil 2.1 (RR00493/6; M-006783-01-2). DACO : 8.2.4.6                                                                 |
| 2523500              | 2002, Acute Toxicity of Imidacloprid SL 200 to Earthworms ( <i>Eisenia fetida</i> ) (M-039455-01-2; MPE/RG 393/01). DACO: 9.2.3.1                                                                    |

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| 2523508              | 1990, Determination of the Acute Oral Toxicity (Ld 50) of NTN 33893 in Grey Partridge ( <i>Perdix perdix</i> ) and Red-Legged Partridge ( <i>Alectoris rufa</i> ) (M-042862-01-2; V-908144). DACO: 9.6.2.3 |
| 2550269              | 1993, Merit 0.62% Granular Insecticide: an Evaluation of its Effects Upon Birds at Golf Courses in the Columbus, Ohio Vicinity (105002). DACO: 9.6.6                                                       |
| 2610254              | 2011, Imidacloprid (NTN 33893): Aerobic Soil Degradation as Influenced by Availability in Soil to Micro-Organisms (M1251372-1; M-403497-01-2). DACO : 8.2.3.4.2                                            |

### A.3.2 Water Monitoring Assessment

N/A

## B. Additional Information Considered

### B.1 Published Information

#### B.1.1.0 Chemistry Assessment

N/A

#### B.1.2.0 Human Health Assessment

#### B.1.2.1 Toxicological Assessment

| PMRA Document Number | Reference                                                                                                                                                  |
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**B.1.3.2 Water Monitoring Assessment**

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## **B.2. Unpublished Information**

### **B.2.1.0 Chemistry Assessment**

N/A

### **B.2.2.0 Human Health Assessment**

N/A



**B.2.3.0 Environmental Assessment****B.2.3.1 Environmental Fate and Effects Assessment**

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